Managing the Small Forest

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READING this bulletin will make no one a forester. It takes much study and long years of experience to do that. But just as a man need not be a doctor in order to give first aid and practice the rules of healthful living, so the owner of the small forest can keep his trees vigorous and productive by following some simple rules of good forest management.

This bulletin tries to show what some of these general rules are and why foresters recommend them. The careful reader will see that some of them, if applied to his own property, will bring both satisfaction and profit. Nevertheless, many principles of forestry that are easy to state in general terms become very complicated when applied to a specific case. And unfortunately, many owners are starting with overcut, run-down, sick woodlands. Finding out what is the matter and then obtaining a prescription for the proper treatment are the first steps in getting started right. Therefore, the owner should consult his local forester, who knows tree management problems in the community. The property owner knows his own land and his needs and desires. By pooling their knowledge the two can work out an effective, individualized, on-the-spot program.

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MANAGING THE SMALL FOREST

By Forest Service, Soil Conservation Service, and Extension Service.[1]

INTRODUCTION

There never was a better time to make a small forest pay. Timber is scarce almost everywhere in the world. Wood products bring good prices. And really good lumber from large, straight, clear logs will always command a market. Investing some time and care, owners of small forests can earn cash and at the same time put their timber in condition to return frequent profits in the future.

For instance, a Burke County, N. C., farmer has paid off on his farm 3 years ahead of time with money from his timber. With the help of a farm forester, he marked old trees—near the end of their growth—for cutting. Then, when his son came back from the Army, they harvested and sold marked pine and hardwood trees. Young, fast-growing trees remain for future cash crops.

This is only one example from hundreds reported in 1946 by farm foresters all over the United States, telling of small forest owners who have profited from well-managed forests and efficient sales methods. Where foresters are available to help, sound management of small forests is being extended every year.

The 4,200,000 men and women, farmers and city dwellers, who own small forests may be surprised to learn that they control 57 percent of all the commercial forest land in the United States and 75 percent of all the privately owned forests. Even in the West more than half of the privately owned forest is in small holdings. All together, these small forests include 261,000,000 acres, about evenly divided between farmers and nonfarmers.

Although the term "small forest" applies to all tracts under 5,000 acres, only a few come anywhere near that size. The average is 62 acres. Seventy percent are smaller than 50 acres, 86 percent smaller than 100 acres, 98 percent smaller than 500 acres.

Our woodlands are a great responsibility. Besides providing lumber and other wood products, forests build up the soil and improve the climate. They give us a steady supply of water and help prevent floods that gully our fields and wash our valuable topsoil away. Nevertheless, we have abused them for the past 300 years, probably because we thought that they were so big they would last forever. Now they must be rebuilt, for without them the United States can hardly live as a prosperous, healthy nation.

In this rebuilding, small forests are of first importance, partly because they make up so much of our very best forest land. The

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other reason is that they unfortunately have been used worse than any other part of our forest land. In 1945, for example, 71 percent of the small owners cut their trees in such a way that the cut-over land had no timber values left, or almost none, and either could not grow a new forest at all or could do so only with difficulty. Only 4 percent cut wisely, leaving their forests able not only to grow but to improve. Farm woodlands seem to be in the worst shape of all. Farmers own about a third of our commercial forest area, but these lands produce only about one-seventh of the Nation's saw timber.

The first person to benefit from a well-managed forest is its owner. The timber it yields will help and give work to many people, but first of all it will put cash in its owner's pocket or at least save him from having to buy fuel and lumber. It will save his land from erosion and will conserve the water he uses. It will bring him profits from land that might otherwise be almost worthless.

Congress has set aside money to help the States provide the owners of small forests with fire protection, seedlings for planting, and advice on forest management. Now an owner, whether or not he is a farmer, can obtain professional advice and, where available, technical assistance, by consulting with his soil conservation district supervisor, by writing or phoning his State forester at the State Capital, or State extension forester at the State Agricultural College. His county agricultural agent also will know where to secure help. So will any officer of the Forest Service or Soil Conservation Service who may be nearby. A forester's assistance is valuable, for he may double the return from woodlands by advising owners on what to cut.

If he is available, the local forester, as he will be called in the rest of this bulletin, will visit the owner's woodland and give on-the-spot advice for managing it. Generally this advice will be free, but the forester expects the owner to follow his suggestions. In a sense this is the owner's way of carrying his share of the responsibility. When the owner can pay for technical service, or if he has a large tract, or cannot do the work himself, he will be encouraged to hire a private consulting forester, who is paid a fee.

A final word—This bulletin will give you sound general advice on managing your small forest for the most profit. Not all of it applies to your land, but as you read you will be able to tell roughly what parts do. Then, under the guidance and advice of the local forester, you can carry out the ideas that will benefit you.

The bulletin is planned especially for small forest landowners east of the Great Plains. However, much of the advice also applies to the Western States. If you own forest land west of the Plains, your tree species, planting techniques, and harvest systems may need to be different from examples discussed in the bulletin; you should always consult a trained forester familiar with your local situation.

Each of the following sections is fairly complete in itself, although Measuring and Selling go closely together. Thus, you can turn quickly to the particular section in which you are interested, without having to read the whole bulletin—though you may want to do that when you have time.

SILVICULTURE: GROWING AND TENDING THE FOREST

WHAT A SMALL FOREST SHOULD LOOK LIKE

NOTE.—This section tells how to manage a forest that is already growing. How to start a forest is taken up in the section beginning on page 12.

Of course, well-kept small forests in Georgia look different from those in Oregon or in Minnesota. But in many ways they are alike. In each the trees are suited to the soil, climate, and locality, and will give a good, salable crop, whether of turpentine, sawlogs, pulpwood, or something else. Poor or surplus trees have been thinned out to give the good ones room. Such a forest has no overripe trees, past their best growing years. It has no diseased or damaged trees, no very branchy or badly shaped trees.

The forest floor will be covered with needles, leaves, twigs, and small branches. (Figure 1 illustrates this and many of the following points.) Such a covering permits soil to absorb the large amounts of water that trees need, and prevents erosion. Beneath the litter a moist, fertile layer of humus covers the subsoil. (On sandy soil the humus may leach away.)

The litter and lack of sunlight on the floor have weakened and killed all grass and weeds. Nothing—neither grass nor young trees—grows on the floor of a close forest in which all trees are of the same age. In mixed-age stands some trees will be mature, some just sprouting, and some at all ages between. In some parts of the South and West stands are naturally more open, and even well-managed forests will have some grass or other plants.

Grazing animals and uncontrolled fire have been kept out. Again, however, some forests in the West and South may be grazed conservatively (but not by hogs) and in the South may have received carefully controlled burning on a forester's advice, usually to reduce the danger of wild, destructive fire.

If the trees are all of the same age the crowns almost touch, to form a sort of ceiling of foliage (called canopy). A mixed-age stand has no continuous canopy. In either case the crowns are healthy and full, and make up about a third of the total height of each tree.

HELPING THE FOREST TO GROW

Once started, a forest probably will grow by itself. It will grow up faster and bring more profit, however, if the owner helps it along. The owner's goal in managing his forest is to have as many trees as he can of the best quality possible. This means keeping the stand neither too thick nor too thin.

Usually a high-grade tree is tall and free from knot-causing limbs for much of its height, and does not taper too much between the butt and the top of the last sawlog. Close stocking produces such trees by making them grow tall and straight in order to get light. Lack of light causes the lower branches to die and break off, leaving the clean trunks shown in figures 1 and 7.

On the other hand, an owner will not get best results unless he makes improvement cuttings to remove the poorer trees so that

the better ones may have room to grow. Indeed, *every* cutting before the final one should be an improvement cutting. Whenever possible, these cuts should be made to pay for themselves. An acre of fully stocked, well-cared-for hardwoods (broadleaved trees) should grow from ½ to 1 cord of wood per year, an acre of good pine from 1 to 2 cords. (Growth is a little slower than this for most trees in the North and faster in the South.) Some of this growth is on main-crop trees, but much of it is on those that will

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FIGURE 1.—Thrifty, mixed-age hardwood forest. The floor is in good shape—the trees are so close together that grass cannot grow. Fire and livestock have been kept out.

have to be thinned out to give main-crop trees room. Thinnings in young stands may make firewood, pulpwood, or bean and tobacco poles. Later cuttings may yield handle stock, pulpwood, fence posts, and perhaps mine timbers, ties or poles, or even sawlogs. Thinnings may not always "pay as they go." Every good thinning, however, will pay for itself in cash when the main crop is harvested. Thus any other profit is clear gain.

Taking Out Weed Trees

In young stands less valuable trees like chokecherry, blackgum, or scrub oak may crowd out better kinds. Sometimes, either through seeds or sprouts, too many young trees come in. Poor specimens or varieties should be cleaned out. If no use can be made of the unwanted small trees, a good way is to lop off only their tops. Then they will live on, shade the ground, and force the better ones to grow tall and straight. To save time, cut only those inferior trees which are actually choking off better ones.

Thinning

Young even-aged stands usually need thinning when 15 to 20 years old. Whenever the crowns of either mixed- or even-aged stands look crowded or have dying branches the forest should be opened up. Enough trees should be cut so that each crown has room to grow one-third or one-half wider than it is. Such a thinning will last until the crowns come together again, perhaps in 5 or 10 years.

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FIGURE 2.—Recognizing that his loblolly pine forest needs thinning, this Arkansas owner is marking with paint the trees he wishes to remove. These trees are 19 years old and average 35 feet high and 5 to 10 inches in diameter.

One rule of thumb for southern pines and hardwoods is to thin so that the average space in feet between two stems equals their average diameters at breast height in inches plus 6. Thus two healthy trees 10 and 6 inches in diameter would have an average diameter of 8 inches. Converting to feet and adding 6 gives 14 feet as the proper distance apart. Other trees may need different spacing. For instance, the rule of thumb with ponderosa pine is that the space between trees should be the average diameter plus 4. Foresters can advise the proper spacing for each kind of forest. These spacings are usually designed to let the owner cut over his entire woodland once every 5 years.

Generally not more than one-quarter of the wood volume in a stand is taken out at any one thinning. Fast-growing trees like

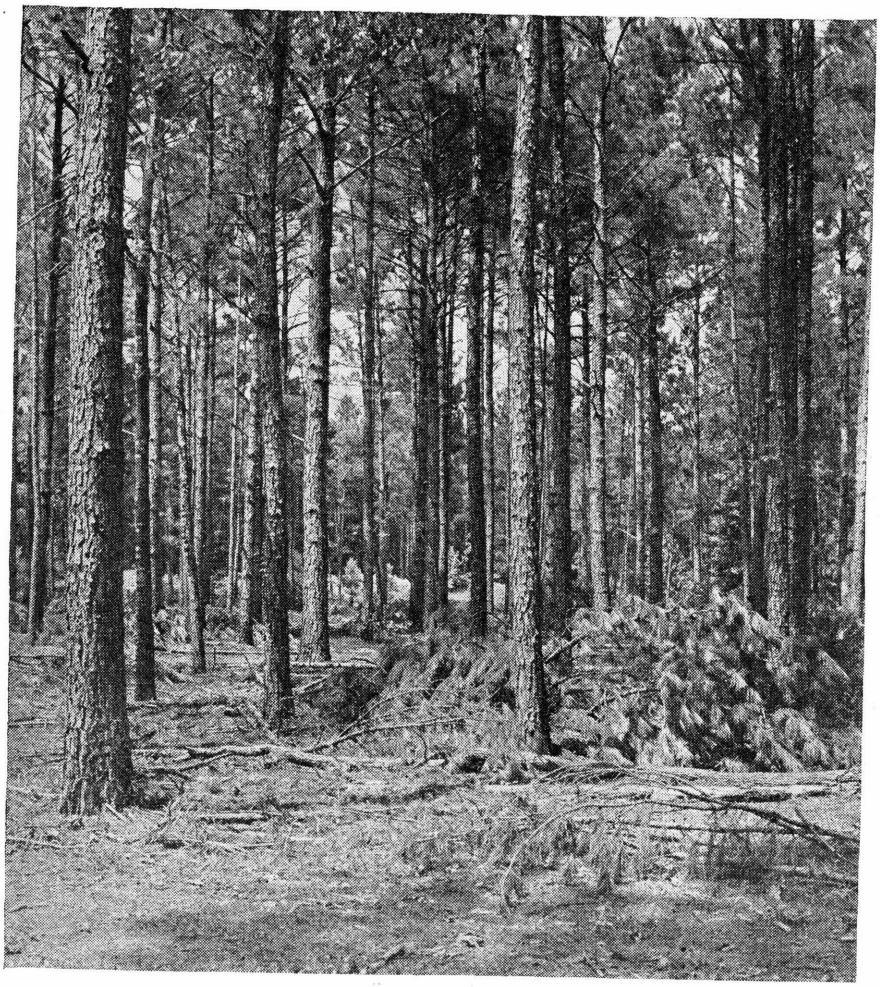

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FIGURE 3.—A stand of shortleaf and loblolly pine immediately after thinning. The Arkansas farmer who owns this land selected, marked, and cut the trees himself. He got about 8 cords of pulpwood per acre and left 150 trees per acre to continue growing.

loblolly and slash pine, cottonwood, yellow-poplar, and sweetgum can be opened up more per thinning than slow growers like white oak, ash, basswood, etc.

These rules are no substitute for common sense. A clump of 8 or 10 good trees with room on the outside but crowded in the center might be thinned to 2 or 3 according to rule. Actually, wise selection and cutting of perhaps 3 might give the whole group enough room. Likewise, a thrifty young tree should not be cut if it is growing even directly under an older tree that will soon be harvested. In short, each tree should be sized up individually for its chances of growing into profitable timber.

Liberation and Salvage Cuttings

Some large trees are so branchy and have such huge crowns that they choke off better formed seedlings or saplings which would grow into good trees if given a chance. These "wolf trees" should be cut out as soon as possible, or girdled or poisoned. Other poorly formed trees—bent, forked, knotty, limby—should be removed also. So should diseased, rotted, or insect-infested ones, and those likely to die before the next cutting. Useless vines of many sorts bend trees or kill them by shading. When they grow on valuable trees, such vines should be killed by cutting the main stem near the ground.

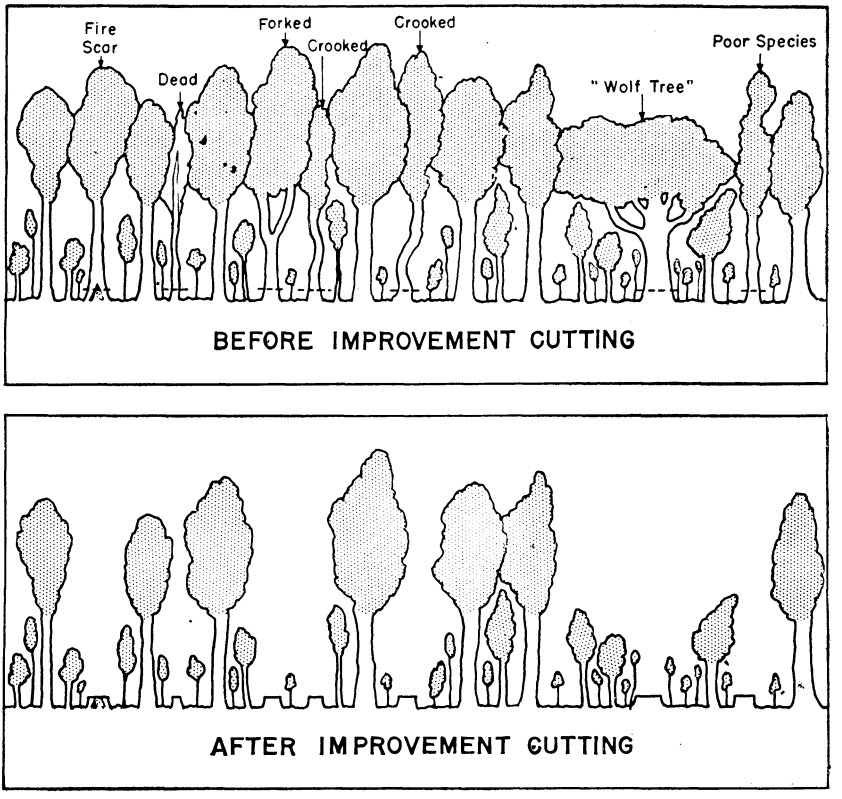

FIGURE 4.—What to take out to improve your forest.

Liberation cuttings are best made in early summer, when the fresh stumps are least likely to sprout. At that time it is also easy to see which trees should be cut.

Overmature trees are no longer growing at a profitable rate and should be harvested before they rot or are damaged. They can be recognized by their flattened crowns, thin foliage, and, usually, by their light-colored bark. Useful trees damaged by fire or breakage should be salvaged.

Pruning

Taking some of the live or dead limbs off a tree frequently improves its value. White pines, which lose their lower limbs slowly, are often pruned. Southern pines intended for high-grade saw timber, and—in the Central and Lake States—black walnut, black locust, and pine and spruce plantations are sometimes pruned.

Pruning is slow work but produces timber which may bring

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FIGURE 5.—Useful pruning tools. The shears are handy for low branches but useless for higher ones, for they cannot be used with a ladder. They sometimes leave stubs which heal over slowly.

premium prices. Before he prunes, however, the forest owner should find out whether he will probably get good prices for his product. His local forester will be able to advise him on whether to prune and how to go about it.

Only about 200 to 225 trees per acre should be pruned. These should be so sound and well-spaced that they can be left for the main tree crop. At the first pruning the trees should be fairly young, 4 to 6 inches in diameter, so that no branches thicker than 2 inches (2½ inches on southern pines) need to be taken off. At this age cuts heal fast and leave only small knots. The best time to prune is just before the growing season begins. All cuts should be very close to the trunk. Stubs take too long to heal and may let in rot and insects. Not more than two-thirds of the total height of the tree, nor more than the lower third of the live crown or top should be pruned at one time. Open-grown longleaf pines, however, grow very slowly for several years if pruned above half their height. A second pruning may be needed some years later to get at least one clear 16-foot log or, on the best timber, to get long, clear poles or two clear logs.

A fairly heavy pruning saw, with a blade 12 to 18 inches long, is the tool most often used. The two saws in figure 5 are good examples. Pruning high branches with a ladder and one of these hand saws does the best job, but a pruning saw on a long pole may be safer and more convenient. Pruning shears are more expensive and not so useful. Never prune good trees with an ax.

HARVESTING THE TIMBER CROP

Harvest cuttings differ from improvement cuttings in that the aim is to cash in on the stand rather than to improve the remaining trees. How it is done, however, decides whether the forest will be completely destroyed or left in shape to produce another crop in 5 or 10 years.

Clear cutting means cutting everything that can be sold or used. Unless land is being cleared for crops, this is the worst way of cutting timber. It means that many years will go by before any more income may be expected from the forest. If the wrong trees come in on the bare land, the next crop may be less valuable. Cutting may be so severe that the woodland will not reseed itself and must be replanted. In the long run, total cash returns from the woodland will be less than under a better method.

In *seed-tree cutting* 10 or more selected, healthy trees 10 to 12 inches in diameter are left per acre, preferably in groups, to restock the woods. All other timber is cut. This method has all the disadvantages of clear cutting except that planting may not be necessary. It has little place in the management of the small forest.

These remarks about clear cutting and seed-tree cutting may not apply to even-aged stands in which all trees mature at about the same time. Such stands are sometimes clear-cut and replanted with seedlings to save the 2 or 3 years that would be needed to restock the area by the seed-tree method. More often they are cut by the seed-tree method. In very large stands strips of trees may

be left standing to reseed the area. Sometimes, of course, cutting is selective. The method recommended by foresters depends on the characteristics of the individual forest.

In the *diameter-limit* method all trees above a certain diameter —perhaps 14 inches—are cut. This method is easy to supervise and apply, but its serious fault is that diameter of a tree alone is not a good indication of whether it should be cut. Weak, deformed, crowded, diseased, slow-growing trees below the limit will be left, and many healthy trees will be cut just when they are growing fastest.

Selective cutting is the best way of harvesting a small forest of mixed age. Here the forest manager looks over each tree to decide whether it should be cut or left to grow. The method combines stand improvement with harvest cutting. Some trees—the diseased or insect-infested, the limby, crooked, or scarred trees, the old ones, and the less desirable varieties—are cut to benefit the remainder. The other trees that are cut are those that are past their best growing period, or can be sold more profitably now than in the future.

The great advantage of selective cutting is that each tree can be harvested at its highest value. Clean, straight, sound, thrifty, young, vigorous, full-crowned, well-located trees of desirable kinds can be left to produce future timber crops.

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FIGURE 6.—A selective cut has just taken the ripe trees from this stand of white pines in New Hampshire. The remaining trees now have room to grow and another crop will soon be ready. Note the low stumps.

Too often trees are cut just when they are making their most rapid growth. Sometimes this is justified by high market prices or by the owner's need for cash. Frequently, however, he takes a real loss by cutting too soon. Many a tree made into ties or pulpwood when it was a foot in diameter would have produced two good sawlogs if left to grow a few years longer.

One way to judge how fast a tree is growing is to measure the rings on a nearby stump of the same species. Suppose that by checking stumps it seems that a given tree is growing 3 inches in diameter every 10 years. If its first 16-foot log now has an estimated top diameter, inside bark, of 15 inches, it would scale 121 board feet, Doyle rule. Twenty years later, having grown 6 inches, it would contain 289 board feet—nearly 2½ times as much. If timber prices remain the same, the log will earn interest at over 6 percent a year.

Selective cutting brings in cash returns every few years, keeps the forest growing at top speed, and allows larger cuts when market prices are good. The owner may find it a little hard at first to tell just which trees to cut, but with thought, practice, and coaching from his local forester, he can learn to do a pretty good job Over a period of years he will be repaid many times for his work

The owner should treat his timber as a crop to be harvested frequently. By selective cutting he can take a partial harvest from the entire forest every 5 or 10 years, or possibly more often. At the same time he will keep his forest productive, with vigorous new trees replacing those harvested.

Marking Trees for Selective Cutting

The best way to start a selective-harvest cut—and an improvement cut too—is to go through the forest with paint brush and pail or a paint gun and mark the trees that are to be felled. Then, after marking is finished, cutting can begin. Choosing the trees and cutting them at the same time causes too many mistakes. Trees can be blazed with an ax or hatchet, but paint works better. It is quicker, easier to see and to erase in case of error, and does not injure the tree—a blaze may let in insects or blue stain.

White and yellow are good colors for marking, and so is medium blue. Whitewash can be used if it does not flake or wash off easily. Paint should be worked into the crevices of the bark so that it will not wash off or be lost if the outer bark peels. If used in a sprayer, paint should be thinned with kerosene.

Mark the trees twice—once at about breast height and once below stump height. Both marks should be on the side of the tree from which the buyers and cutters are most likely to see them.

PERPETUATING THE FOREST

Most small forests of mixed age, unless damaged by fire or grazing, reseed themselves. (If planting is necessary to renew the forest, see the next section.) In woods fully stocked with even-aged trees of about the same size, no seedlings will come up and none should be encouraged. Such a stand can be harvested in three successive cuttings.

The first cutting opens up the canopy a little, to make the leaves on the forest floor rot faster and to expose the mineral soil. The

remaining trees become wind-firm and, because their crowns get more light, produce more seed. When the floor is in good shape, later cuttings made during winters following heavy seed crops (good seed years come only once in a while) open the way for a crop of seedlings. Neither of these two cuttings should be heavy enough to encourage the growth of much grass or weeds. The last of the old trees may be cut when the seedlings no longer need their protection.

Sometimes foresters will recommend that even-aged stands be harvested by the seed-tree method because it best allows for growth habits of certain species. Owners who cut clear and replant may save waiting 2 or 3 years for natural restocking of this kind of forest.

Previously pastured or burned forest, if not too severely damaged, will sometimes recover and reseed if livestock and fire are kept out. Even a good seed year, however, may not start young trees on the packed or sodded ground unless the owner works it or lets hogs root it up before the seed falls. To prevent undesirable species from reseeding, cut them before pasturing stops.

Hardwoods often sprout from stumps. Most conifers (cone-bearing trees), apart from young shortleaf and pitch pines, do not. Basswood excepted, most hardwoods do not sprout well after they are 60 years old. The low stumps of trees cut during winter or very early spring sprout best, and their shoots are less apt to be injured by their first winter than those from summer-felled trees. For sprouts, stumps should be uninjured and should be cut clean, preferably with an ax. The tops should slant to shed water. In thinning, favor the shoots growing low on the stump.

PLANTING TREES

"Should I plant trees?" is a question each farmer or small landowner ought to ask himself from time to time. If he cannot answer it himself he should ask his local forester, soil conservation technician, or county agent. They will answer in the only good way: in terms of the individual piece of land under consideration.[2]

Here, however, is some general advice on forest planting for growing timber. Trees of a useful variety successfully started on the right land are almost sure to return a profit to their owner. How much the profit will be depends mainly on prices at harvest-time and on how good the site is. The forest will also yield many products needed for the farm, such as posts, firewood, lumber, and timbers. It will be a home for wildlife; it may serve as a windbreak; it will conserve moisture and prevent erosion; it will give the owner and his family recreation.

In spite of these benefits, trees should be planted only on land that is better suited for growing trees than for anything else. Trees should *not* be planted on a piece of land if it is level and fertile enough to grow good cultivated crops without eroding or if it can make improved pasture and additional pasture is needed.

[2] Trees are often planted solely as windbreaks, as Christmas tree farms, or to control erosion. But these projects have many special problems. Before starting them, see a county agricultural agent, soil conservation technician, or local forester, who will be able to recommend the right trees, planting methods, and care.

With a few exceptions forest trees should be planted: (1) On cut-over areas or in forests so run down that they are not reseeding, or are reseeding too slowly; (2) on land that will be or has been ruined by sheet or gully erosion; (3) on rocky, hilly, or worn-out land; (4) on land restocking to worthless kinds of trees; (5) on odd corners of good land too small or inaccessible for cultivated crops or pasture.

WHAT TREES TO PLANT

For landowners who wonder what kind of trees to plant foresters have one simple rule: *plant the kinds that have already done well in your locality.*

Conifers will grow, generally, where hardwoods will not—in worn-out fields and pastures, sandy areas, cut-over and burned-over woodlands or on shallow, dense or cloddy soil. They will survive even if they are not cultivated after planting, and, other things being the same, will produce more sawlogs than most comparable hardwood stands. Hardwoods grow well in deep, rather loose, crumbly ground with plenty of room in the soil and subsoil to develop roots. All trees, but especially the hardwoods, need much water and do best where the soil absorbs it readily and is loose and deep enough so that their roots can get it easily.

Generally it is best to plant the trees which grow fastest, provided, of course, that their products are salable.

In the central region—Ohio, Indiana, Illinois, Iowa, Missouri, and the western parts of Kentucky and Tennessee—shortleaf and pitch pine will grow on inferior soil and jack pine on distinctly bad locations. Eastern red oak, white ash, cottonwood, white and red pine, and Norway spruce will be satisfactory on medium sites. Black locust may be planted on good land and yellow-poplar and black walnut are recommended for planting on very good sites.

In the southern Appalachian region—the eastern parts of Kentucky and Tennessee, West Virginia, the western parts of Virginia, North Carolina, north Georgia, and northwest South Carolina—Virginia (scrub) pine and redcedar are reserved for the worst land. White pine grows on poor soil, but not as poor as shortleaf and pitch pine will prosper on. Yellow-poplar, black locust, and white ash do well on next best soils. Black walnut thrives on good land.

In the Piedmont—the central parts of Virginia and of North and South Carolina—foresters suggest Virginia (scrub) pine for barren land, loblolly and shortleaf pine and redcedar for poor to moderate soils, and yellow-poplar, black walnut, and black locust for the best ground.

Within their ranges in the South, longleaf pine may be planted on dry, sandy, or sandy loam soils; slash pine on moist, sandy loam soils; loblolly pine on almost all soils at lower elevations; and shortleaf on most soils that are not too wet. White pine grows well on most elevations in the mountains, except on windswept and exposed ridges. Various hardwoods, such as walnut, are often interplanted in the small forest, but they need good farming soils.

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FIGURE 7.—The slash pines in this South Carolina woodland were planted as year-old seedlings. Ten years later, when this picture was taken, they averaged 30 feet high and 5 to 7 inches in diameter at breast height.

In the Lake States—Wisconsin, Minnesota, and Michigan—and in New England and the northerly part of the country east of the Mississippi River generally jack pine, and sometimes Scotch pine, is planted on the worst lands. Red pine (Norway pine) will grow where white pine will not. White pine, Norway spruce, and perhaps white spruce are planted on fairly good land. Black walnut will grow on good soil in this section, but is not yet widely planted. White ash, red and white oak, and yellow-poplar are among the chief hardwoods planted, and all require the best land.

SOW SEEDS OR PLANT SEEDLINGS?

Usually it is best to plant seedlings. Only nut trees, like oaks, hickories, and walnut, which have such long taproots that they are hard to transplant, are easier to start from seed. However, within their ranges, shortleaf and loblolly and a few other pines are sometimes grown directly from seed. Rodents, drought, and birds are the great enemies of direct seeding. In a dry year or when rodents are numerous direct seeding of pine may fail entirely.

Broadcasting the seed, even on prepared soil, is very unreliable. When sowing hardwood seeds, put them on evenly spaced spots where the soil has been loosened and heavy sod removed. Make holes with the fingers or hoe and put two walnuts, hickory nuts, or acorns in a spot, several inches apart. Cover seeds with soil to a depth about equal to the width of the seed, and firm the soil. Fall is a better time to sow these nuts than spring, unless there is danger that squirrels, mice, or hogs will dig them up and eat them. In this case nuts should be carefully stored where they will not dry out and planted in the spring as soon as the frost is out of the ground.

To sow pine seeds first make a small spot of bare soil 4 to 6 inches across. Distribute 10 to 15 seeds in the spot, cover the seeds with ⅛ inch of soil, and firm it with the hand. It is important not to cover the seed too deep, and seeding in a shallow trench made by drawing the finger or a stick across the bare spot will allow better judgment of the depth. On areas eroded bare a light mulch of litter not over ¼ inch thick should be placed on each spot. In this case the seed would not be covered with soil. Fall is the best time for sowing pine seeds.

PREPARING TO PLANT THE SEEDLINGS

When to plant seedlings.—Plant when soil conditions are good after growth stops in fall and before it starts in spring. If the seedlings may frost-heave, plant them in spring after frost is out of the ground and before the new growth starts.

Spacing the seedlings.—In general, the more shade a tree tolerates the closer it should be planted. Close spacing, by reducing the number and size of branches, increases the value of the future sawlogs. Spacing usually is from 6 by 6 to 8 by 8 feet apart. Spruce, sugar maple, and hickory grow well under shade. Red, loblolly, and slash pines, cottonwood, and black walnut do not.

Close spacing is best also on unfavorable sites, or on better sites which cannot be cultivated after planting. The extra trees offset deaths and protect the soil by shading it. Species that are branchy in open stands should be planted closer than those with straight, single stems. Rapid-growing kinds are spaced wider than slow ones. A good demand for products removed in thinning will justify close spacing. Again, spacing may be wide on lands with scattered brush. The cost of planting in furrows, incidentally, is reduced by planting fairly close in the furrow but increasing the distance between furrows.

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Generally speaking, the aim should be to have around 1,000 trees growing per acre when the plantation has become well started. A spacing of 5 by 5 feet takes 1,742 trees per acre; 6 by 6 feet, 1,210 trees; 6 by 8, 908 trees; 8 by 8, 680 trees per acre.

Mixtures.—Planting two or more kinds of trees together is a little more troublesome than setting out pure stands, but often has distinct advantages.

If one kind is badly damaged by insects or disease, or turns out to be unsuited to the land, the other kind may still grow into a good timber crop. Furthermore, when trees growing in mixture are attacked, damage is likely to be less severe than in pure stands. Thus loblolly pine mixed with slash pine is less subject than pure loblolly stands to attack by the pine tip moth, which seldom bothers slash pine. And even if the moths ruin the loblollies, the slash will keep on growing. Northern pines are often mixed for the same reason, sometimes with hardwoods. A hardwood-and-pine mixture also discourages the southern pine beetle. In the South again, longleaf pine is often planted with slash and loblolly because a fire that will kill the other trees will probably not destroy the longleaf. When longleaf pine is planted in mixture, three or five rows of it should be alternated with three or five rows of other species. This prevents overtopping of the longleaf during its characteristically slow early growth.

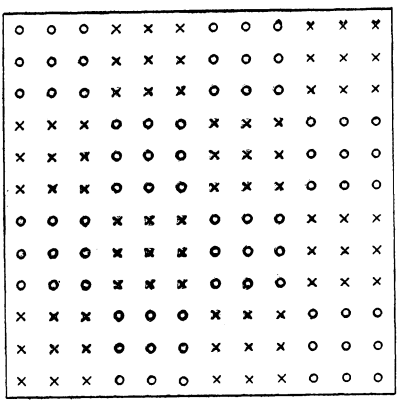

FIGURE 8.—Block planting is one way of mixing two species.

Mixed stands allow close use of the land, for trees that grow in shade can be mixed with those that do not. In general, the species that are mixed should be trees that grow at the same rate.

In block planting different species of trees are set in squares of 9, 16, or 25, but with only one kind of tree in a block. Putting in several rows first of one kind of tree and then of another is called strip planting. It is a good method, as is the "bucket mixture" used by the planter who fills his pail with seedlings and plants them as they come to hand. Alternating single rows of trees is not recommended.

Buying the seedlings.—When he has decided what species he will plant and how many seedlings he will need, the forest owner is ready to order seedlings. These may be obtained from privately or publicly operated nurseries. In many instances, seedlings are available through soil conservation districts. State nurseries sell seedlings at cost or less. Orders should be sent in 6 months in advance. County agents and local foresters usually have order blanks. One should try to get seedlings raised from seed that grew within 100 miles distance and 1,000 feet of altitude of the proposed planting site.

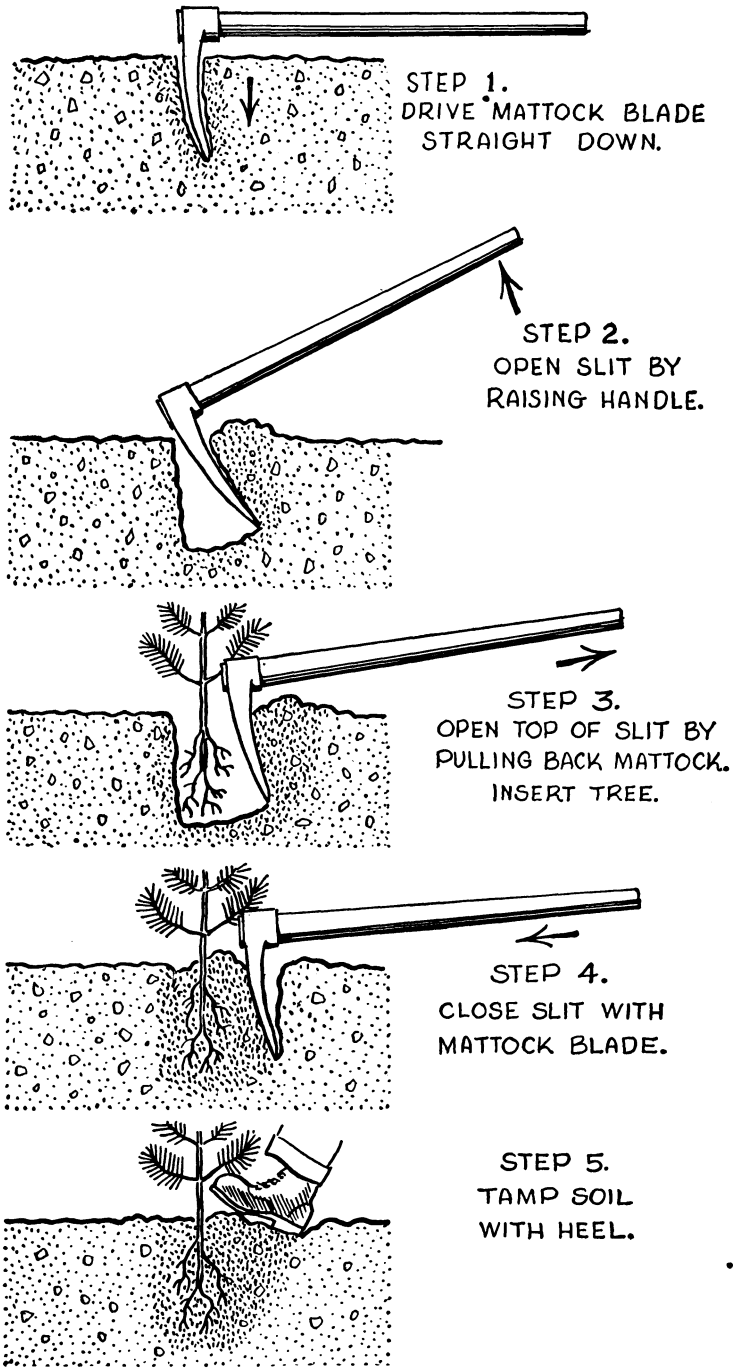

FIGURE 9.—Planting a seedling with a mattock.

PLANTING THE SEEDLINGS

When the seedlings arrive, the bundles should be loosened a little, moistened with water, and kept in a cool, shady, well-ventilated place. If the seedlings are to be kept more than 2 or 3 days before being planted, the bundles should be undone and the roots of the seedlings placed in a trench in the ground. The roots should be kept covered with moist soil or sand, firmly packed to remove all air spaces. The seedlings are dug up from the trench as needed.

Methods of planting seedlings.—Ordinarily the ground of old fields, pastures, and cut-over areas does not need much preparation before planting. In the Central region it is enough to make small scalps 16 to 18 inches wide in heavy sod or dense weeds. Here planting on heavy soils should be done around April, never in fall, because of the danger from frost heaving.

In the southern Appalachian section, small scalps will remove heavy weeds or grass. Using a planting bar (fig. 10) in contour-plowed furrows is the cheapest way of setting out trees where competing plants have to be removed.

The planted tree should be set a little deeper than it was at the nursery. Its main roots should be nearly straight and should not be crowded, or doubled back, wound, or sharply bent. There should be no air pockets at the bottom of the hole. Moist soil should be firmed, but not packed too tightly about the roots, and the tree should be upright.

Hole planting works well on rough, rocky land and for trees with spreading root systems. Dig a hole deep enough to hold the tree roots. Leave one side vertical and place the seedling against it ¼ to ½ inch deeper than it grew in the nursery. Pack some loose surface soil around the lower roots, then fill the hole level and press down the soil with your foot. Be sure that the hole is deep enough for the roots. A mattock, long-bladed grub hoe, shovel or spade makes a good tool (fig. 9).

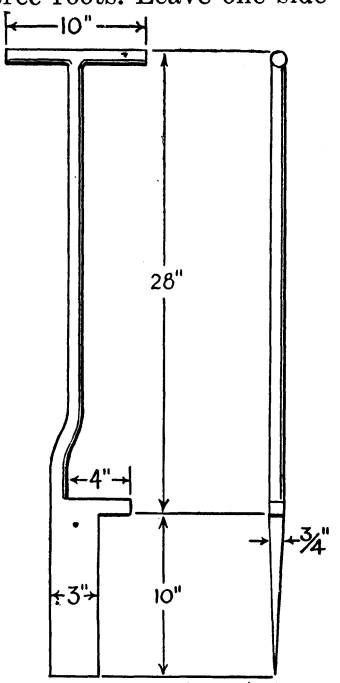

FIGURE 10.—Planting bar.

The *slit method* is faster than hole planting. It works best on smooth land with light to medium soils and with trees having one main root. A mattock or spade will serve, but the best tool is a grub hoe with an 8- or 10-inch blade—at least as long as the roots of the trees being planted. The planting bar (fig. 10) used where no scalping is needed or where sod has been removed by plowing furrows, is even faster.

In some States foresters have developed tree-planting machines. Where they can be used, these machines help speed the job and save labor.

Cultivation.—Where planted trees can be reached easily with a horse or tractor cultivator, cultivation for 2 or 3 years after planting will get them off to a good start and reduce losses. Heavy sod, for example, almost always kills a hardwood plantation. Cultivation is necessary when rank weed growth overtops and smothers the planted trees. But slash and loblolly pine should not be cultivated, because cultivation favors greatly an increase of the destructive fusiform rust on the trunks.

Young plantations *must* be cultivated, however, on the prairies, and in other regions where they do not grow naturally, or where rainfall is light and they cannot be irrigated.

PROTECTING THE SMALL FOREST

It goes without saying that if the owner of the small forest is to gain the most from his investment he must protect it as well as he can against damage. Fire, insects, disease, storms, and grazing are some of the enemies of the forest.

FIRE

Each year fires cost the owners of small forests from 15 to 20 million dollars. Yet the cash value of the wood destroyed is only a part of the damage. Burning kills some of the larger trees and weakens and slows down the growth of others. Bark beetles and diseases enter easily through the burned places. Seedlings and young trees needed to establish another forest are killed. Fire may destroy the fertile, moisture-holding litter on the forest floor, robbing trees of nourishment and perhaps starting erosion. Fire injuries often lower the sale value of timber products by half or two-thirds. Woods fires frequently destroy farm buildings and fences. And sometimes they take human life.

Preventing Fire

Everywhere it is better to prevent a fire than to have to put it out. Most fires are man-made, either intentionally or by carelessness. In the South, carelessness by outsiders causes a quarter of the fires in small forests. The negligent owner or his neighbor starts 10 percent of farm forest fires. Nearly half of all southern woodland fires are started deliberately. The owner thinks that burning his woods will improve grazing, kill destructive insects like the boll weevil, bean beetle, and ticks, drive out snakes and other vermin, or improve hunting. Damage to the forest from deliberate and repeated burning, however, usually far outweighs any advantage gained from improved grazing. The destruction of a few snakes and insects also does not make up for the harm done. Boll weevils hibernate within 150 feet of the cottonfield; burning farther than that from field edges is worse than wasted. Destroying cotton stalks early in fall is a much better way of controlling this pest. All sorts of game need the unburned forest as protection against their natural enemies.

Cooperating for protection.—Fortunately, many small forests can be easily protected from fires. In the North, where the forest is usually surrounded by cultivated fields or pastures, ordinary care to prevent fires and quick action on those that do start is all that is necessary. In the South and West, however, small holdings are often part of larger forest areas. Here community action is

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FIGURE 11.—Wishing to burn the brush in his field, this North Carolina farmer wisely rakes a firebreak first, clearing away grass and litter right down to the mineral soil. He will burn the brush one or two piles at a time, while his helper watches at the edge of the woods for spot fires caused by blowing sparks.

needed. In most States the State forester, aided by Federal funds, maintains a fire protection system. In some States fire districts are organized in which private-forest owners pay part of the cost. Forest owners may have to take the initiative in securing protection, but they will find State and Federal organizations anxious to help. Solutions vary. The important thing is that fires can almost always be stopped where enough timber owners really want to stop them.

Cleaning up danger spots.—Each forest owner, however, can himself do much to prevent fire. Heavy slash left after logging should be pulled away from standing trees. When desirable, as it generally is in the West, slash should be burned, but only during damp weather and under the direction of the local forester. The tops and other useless parts of windfalls and other recently killed timber should be safely disposed of. Weeds, grass, and brush along the edges of fields should be cut or grazed before they dry up to

become hazards. Passing motorists, or a spark from a locomotive, may start fires along roads and railway tracks if flammable material is present. Flammable trash should be cleaned up. During long dry spells it may be necessary to keep out hunters and other visitors. Fires must not start during logging, turpentining, or sawmilling. Woods burning should be done only under the supervision of the local forester or fire warden whose main job is fire protection.

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FIGURE 12.—Plowing a firebreak.

Firebreaks.—Where forest areas are large, or where small holdings adjoin, the forester may advise plowing firebreaks to divide the forest into 20- or 30-acre blocks. A firebreak may stop fire from spreading to or from a neighbor's forest. If it encircles the forest, it will keep out grass fires. The break is made by plowing or otherwise removing anything that will burn from a strip 4 to 6 feet wide (fig. 12). In a high wind, fire will jump across the break, but even then it gives the fire fighter a place from which to start a backfire. Of course, after they are made breaks must be kept clear of flammable leaves, grass, and other trash.

Fighting Fire

Neighbors, of course, can help each other not only in preventing fires, but in cooperating to find and fight fires. If they are alert, especially during dry seasons, they will often catch fires

when they are small and easy to extinguish. Anyone who sees a fire should notify the proper people—the landowner, the fire warden if the blaze is large, neighbors who may be needed to fight it, and anybody else concerned.

Tools.—Anyone who may have to fight a fire should keep a few fire-fighting tools in some handy place where they can always be found. Useful implements are a good hoe or rake to clean firebreaks, an ax for chopping down burning snags, a shovel to throw dirt on the fire, and a water bucket for wetting down smouldering embers. In the South many farmers make their own fire swatters by fastening a 10- by 18-inch piece of old belting to a hoe handle (fig. 13). Some use a large burlap bag or a pine top for this purpose. (Fire fighters should have plenty of drinking water available.)

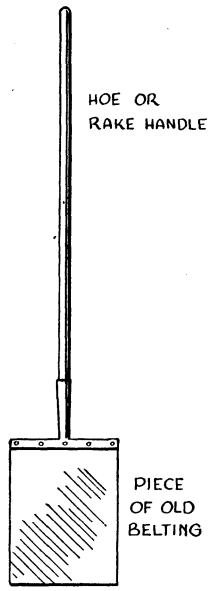

FIGURE 13.—A homemade fire swatter.

Attacking the blaze.—The way to start to put out a fire is to size it up—to find the best way to attack it. Generally it should be checked first at its head, the place where it is burning fastest. This can be done by beating it out, making a firebreak in front of it, or wetting down the burning material with water. After the head is under control, beat out the fire or make a fire line along the sides and rear. Take advantage of any trails, roads, or firebreaks that will help to stop it. Of course, firebreaks should be kept clear to prevent the fire from crossing them. Be sure the fire is out before leaving it.

Backfires.—When fires are too large or move too fast to be fought directly, backfiring may be necessary. The object of this dangerous practice is to burn a clear space in front of the oncoming main fire, causing it to die for lack of fuel. Because it may do unnecessary damage, or may jump the firebreak that was intended to hold it in, the backfire must be very carefully planned and closely watched. It is so dangerous that it should be used only as a last resort.

DISEASE

Disease and insects together are said to destroy more timber yearly than fire does. Both slow the growth of many trees that they do not kill outright.

Some loss may be unavoidable, but much can be prevented by careful management. A forest owner whose trees are being damaged seriously should promptly consult his local forester. There are many diseases of forest trees. Some of the more important types are discussed here.

Heart Rots

HEART ROTS cause millions of dollars' damage to standing timber in the United States every year. Nearly one-fifth of the saw-timber

volume in eastern hardwoods is cull, largely because of decay. These rots are caused by fungi. Many of them form conks or shelves of growth on infected trees (fig. 14).

F18306

FIGURE 14.—A tree with rot conks like the ones on this yellow-poplar is seriously decayed and should be removed. It will hardly make anything except fuel wood, however.

Heart rots starting in the upper part of the trunk cause about half of the total cull in eastern hardwoods of merchantable size, and over three-fourths of the cull in southern pines.

BUTT ROTS are those that start at the base of trees. Fire, logging, and grazing cause wounds on trees through which these rots may enter. Big wounds take longer to heal than small cuts,

and so give rot a better chance to start. Fire prevention, careful logging and skidding, and elimination of grazing damage will greatly reduce butt rot. Figures for several eastern hardwoods show, for example, that in fire-scarred trees cull for butt rot runs to 15½ percent. Cull for butt rot in unscarred trees is only 1½ percent. Butt rots may also enter through roots, especially in conifers.

Many hardwoods sprout from stumps. The parent stump sometimes transmits butt rot to the sprouts, most often to those that grow high on it. Hence thinning should favor low-growing sprouts as being less likely to develop rot. When sprouts are being grown for large timber crops, those from stumps under 6 inches in diameter are to be preferred. Choose those that start nearest the ground and trim out the extra ones before they are over 2 inches thick.

After logging or bad ice or wind storms the forest owner should salvage those trees so badly damaged that they are likely to begin to rot.

Unless it is done carefully pruning may let in rot. Follow the suggestions for pruning on page 8.

Cankers

Most cankers of hardwood and softwood trees alike are caused by fungi. These fungi, as do the rots, produce great numbers of tiny spores (seed) that are commonly carried long distances by the wind. Figure 15 shows a typical hardwood canker. Such cankers may resemble mechanical injuries at first, but they remain open and may grow larger while ordinary wounds heal. Hardwood cankers seldom kill the tree. They do deform it, however, and the rot that sets in behind them often causes the tree to break at the damaged spot.

Unless they will grow enough to be useful, severely cankered trees should be cut out. When a whole hardwood stand is badly cankered, it may be wise to allow softwoods to come in to replace it. Vigorous yellow-poplars, however, often have many cankers while young but usually heal over these sores in 20 to 25 years.

Rusts

Most of the important pine cankers are caused by fungi called rusts. Rusts usually produce orange blisters, especially noticeable in spring. They often spend part of their lives on one kind of plant and part on another, a fact that helps control some of the worst of them.

WHITE PINE BLISTER RUST (fig. 16) attacks any of the five-needled pines and has now spread through nearly their whole range. The rust fungus spends part of its life on pine and part on the leaves of currant or gooseberry bushes, which are alternate hosts of the fungus. Rust spores formed on these alternate hosts spread to and infect pine in the summer and fall. Blisters develop on the pine in spring, about 3 years later. Unless infected limbs are removed in time, branch blisters will spread to the trunk and

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FIGURE 15.—A canker on a sugar maple.

kill the young tree by girdling it. Young trees die fastest, for they are girdled soonest. Older ones can usually be harvested before they die.

Control.—Destroy *all* gooseberry and currant bushes in the stand and for about 900 feet outside. If blistered branches are cut before the rust gets to the trunk, infected trees may sometimes be

FIGURE 16.—White pine blister rust.

saved. To give infections time to show themselves, stands should not be thinned for at least 3 to 5 years after the gooseberry and currant bushes are destroyed. The trees left after thinning will probably be the slightly suppressed ones, on which the disease hazard is less.

SOUTHERN PINE FUSIFORM RUST attacks chiefly loblolly and slash pines. Its alternate hosts are the oaks, especially the pointed-leaf or black oak group. The oaks are not damaged much by the rust. On pine the cankers are swollen, spindle-shaped areas on small trunks and branches, or large sunken spots on bigger trees. In

early spring they form very noticeable orange blisters. Pines 1 to 10 years old are more likely than older ones to be killed by cankers girdling the trunk.

Where infections are serious, landowners should plant the more rust-resistant longleaf, throwing out of the planting stock any seedling with the slight stem swelling that shows that it is already infected. Many trees in even a heavily infected stand can be saved if the cankered branches are pruned before the rust reaches the trunk. The critical time for this is when the trees are 3 to 5 years old.

The round rust galls on Virginia and shortleaf pine are caused by a similar but much less damaging rust.

THE WESTERN GALL RUST can infect directly from pine to pine. It attacks a number of pine species in the West, particularly Jeffrey, ponderosa, lodgepole, and Digger pines. It is worst on seedlings and saplings, killing some and stunting and deforming many more. Unlike other rust diseases that can be controlled by the removal of alternate hosts, this disease requires the removal of infected pine trees, especially those with galls on the main stem.

Other Pine Diseases

BROWN SPOT of pine needles attacks all southern pines, but especially longleaf seedlings, killing many and preventing the others from growing. Small spots, light gray green in color, first appear on the needles. The spots change rapidly to brown, encircle the needle, and kill the part above the band. Severe attacks may almost strip the tree each year. The disease is worst in moist seasons. The local forester will be able to suggest control measures, perhaps careful burning at a prescribed time of year.

The LITTLE LEAF DISEASE has seriously harmed shortleaf pine in some parts of the South. It attacks trees 20 or more years old. Sick trees look starved, grow less and produce shorter needles each year, and die in about 7 years. The needles sometimes turn yellow but may stay green during the early stages of the disease. Loblolly and Virginia pines are hit along with shortleaf, but longleaf rarely is. Neither cause nor cure is yet known. If cut promptly, however, diseased trees can often be sold for lumber, pulpwood, fuel, cross ties, and poles.

INSECTS

Trees weakened by rot, disease, fire, grazing animals, logging, or storms offer good homes for thousands of kinds of insects, some of which do great damage. But insects can also damage trees that seem to be perfectly healthy, with no weakness noticeable.

Leaf-eating insects are easily seen, of course. Fine sawdust and sometimes sap or gum may come out of the holes that boring or girdling insects make. Bark beetles make regular wavy passages or galleries on the inner side of the bark. Under certain kinds of insect attack the leaves of the hardwoods change to their fall colors, while the softwoods turn brown or red.

Careful forest management, which prevents injuries to trees and removes those already sick or weak, helps to prevent insect

attack. Tiny parasites destroy some of the insects. Birds eat many of them, woodpeckers being especially fond of the grubs of bark beetles and borers.

Dendroctonus Beetles

Members of this group are by far the most destructive bark beetles attacking cone-bearing trees in North America.

The WESTERN PINE BEETLE (*Dendroctonus brevicomis*) attacks ponderosa pine from California to British Columbia and as far east as Montana. The MOUNTAIN PINE BEETLE (*Dendroctonus monticoalae*) destroys western white, lodgepole, sugar, ponderosa, and other pines in the same general region. Normally these insects do little damage, but sometimes epidemics develop and many trees are killed. When so many trees are attacked that an epidemic seems likely, forest owners sometimes try to head it off by destroying beetle broods before they multiply too greatly.

Felling infested trees and peeling them allows salvage of the logs. Burning the bark, or, where possible, exposing it to the hot sun, makes certain that all the bark beetle larvae in it will die. Sometimes the trees are felled, piled, and burned. Lodgepole pines can sometimes be sprayed with oil and burned standing. Another effective treatment is to spray the infected part of the trunk, either felled or standing, with some penetrating spray containing orthodichlorobenzene.

The SOUTHERN PINE BEETLE (*Dendroctonus frontalis*) (fig. 17) girdles and kills healthy southern pines of all species. It bores through the bark and makes long, winding, S-shaped galleries in the inner layers of the living bark. A tree attacked in early summer will be dead and abandoned by midsummer. Brown needles and numerous small holes show that the young beetles have grown up and left the tree. The foliage turns yellowish green 10 days or so after infestation. Pitch tubes often appear on the middle and lower trunk, but should not be mistaken for the larger tubes of the turpentine beetles, which are nearer the ground. As with the Ips beetles, there will be spots of reddish-brown boring dust in the bark crevices. Blue stain always marks infected trees.

Forest owners must cooperate in beetle control, for a clean area will be attacked from an adjoining infested forest. If a stand is infested, all the trees attacked, except those the beetles have left, should be cut and marketed immediately, and the slash, tops, and bark burned or scattered directly in the sun to dry quickly. Nonmerchantable infested trees must also be treated, of course. Unpeeled logs may be laid in a north-and-south direction for 3 days directly in the hot sun and then turned over and left 3 more days.

Rain or low temperatures check the beetle, but in dry seasons control efforts may be almost useless. When rainfall is 1 inch or more short during the growing season (March to October) summer cutting of timber is not advisable. Since outbreaks usually occur in pure, even-aged stands, owners should consider mixed plantings. Or they may let desirable hardwoods grow up in pure plantations.

IPS BARK BEETLES, also called engraver beetles, are often confused with turpentine beetles and the southern pine beetle. Figure 17 illustrates the differences. Ips egg galleries are straight or star-shaped, whereas those of southern pine beetles are S-shaped. Ips usually attack healthy trees only when large summer logging operations stop suddenly. They then increase swiftly in the slash and may attack even the thriftiest trees. Thus summer logging should continue into cold weather. To control Ips, fell and bark infested trees. The bark need not be burned.

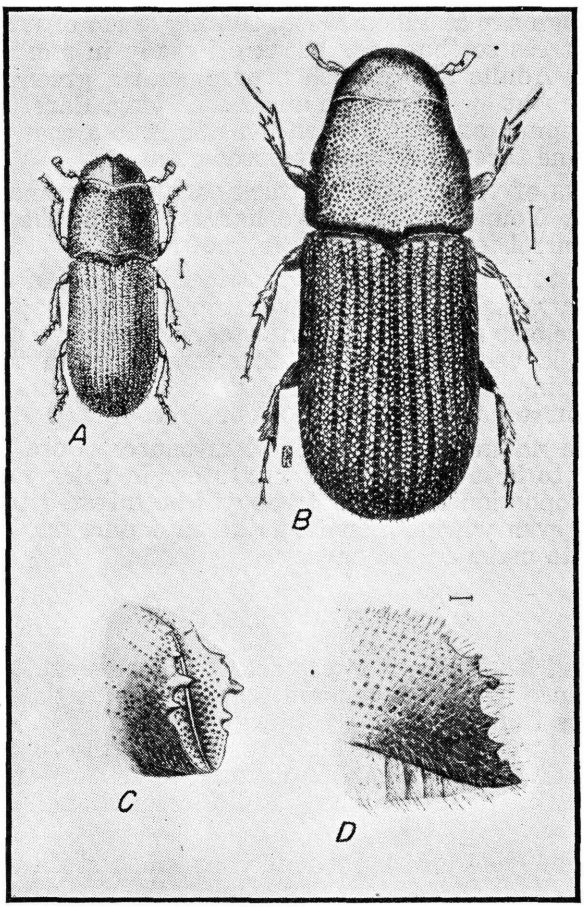

FIGURE 17.—Three enemies of southern pines: *A*, The southern pine beetle—rear end of its abdomen has convex shape; *B*, a turpentine beetle, shaped like *A* but larger; *C* and *D*, rear views of Ips bark beetle—note scooped-out shape and toothlike projections. Short lines show approximate lengths of beetles.

TURPENTINE BEETLES (fig. 17), like Ips, seldom require special control. They will attack wounded pines, but seldom kill trees, and normally breed in stumps and felled logs.

SAWYERS or FISH BAIT are the grubs of another beetle attacking softwoods. The adult is about an inch long, mottled gray in color. Mature larvae are about 2 inches long, footless, and grayish white. Various kinds of sawyers attack felled pine, spruce, and fir in the Southeast, Northeast, and West. By boring holes in the heartwood, these grubs damage sawlogs and reduce much timber to low grades or cull. Where sawyers abound, trees felled in midsummer should be logged within 2 weeks.

TURPENTINE BORERS attack the turpentined faces of longleaf and slash pines that have been injured by dry-facing, heavy scraping, or fire. The larvae, long, whitish grubs about 1½ by ⅜ inch, tunnel through sap and heartwood, ruining much of it for lumber, weakening trees so that they break off easily in storms, and admitting rot. Adults are grayish bronze with a greenish metallic luster, and about ⅜ inch broad and 1 inch long. Careful scraping, shallow chipping, and fire prevention will keep a coat of resin on the turpentine faces and prevent borer damage.

TIP MOTHS of various kinds attack softwoods in most parts of the country. Young loblollies are hardest hit in the South. No practical control in forest stands is known.

The WHITE PINE WEEVIL, the worst insect enemy of the eastern white pine, attacks the tree wherever it grows. Norway spruce and jack pine are also often heavily infested, as are some other varieties. Weevil larvae feed on the tender inner bark of the tips and leaders, causing these parts to die. When the leaders are killed, trees grow more slowly and may fork or bend.

There are no inexpensive control measures. Pure stands are more likely to be attacked than mixtures. In thick pure stands, however, proportionally fewer trees will be infested than in thin stands, and even when its leader is killed a pine may straighten out enough to make a good sawlog.

GRAZING DAMAGE

Good forest is usually poor pasture. With some exceptions, land cannot produce heavy timber and good forage at the same time. Where heavy timber can be grown, grass on the forest floor is a pretty sure sign that trees are too few or that the forest is being mistreated. Except on naturally open types of forests, as in the southern coastal plain and the West, forests should be left free to grow timber.

One acre of good pasture will feed as much stock as 10 to 50 acres of woodland. Grass grown even in partial shade has considerably less food value than that grown in full sunlight. Thus dual use of land for timber and grazing is inefficient. Pastures can often be improved so that they will support the animals the year around. Then livestock need not be run in the woods at all. It may even be necessary to clear a few acres of forest to get enough pasture. Cash from timber sales may buy supplementary livestock feed. If the cattle need shade, a small corner of the forest can be fenced off for them.

The owner, whatever he decides on with the help of his local forester and county agent, should distinctly separate forest land

from pasture, with a good fence. If he does, he will grow better livestock *and* better timber.

Hardwood Forests

In heavily pastured hardwood stands there are almost no young trees or seedlings. The soil, if packed and trampled, keeps out air. Rain runs off quickly instead of soaking in, and trees thus get less water than they should. When the surface roots are trampled and damaged the tops begin to die, letting more sunlight down to the floor. Grass then appears, depriving the trees of even more moisture. Livestock break off young trees or branches, and disease and insects move into the wounds. Though they eat the best seedlings and young trees, farm animals get little nourishment from hardwood forests.

Horses should never be allowed to graze hardwood forests. Hogs will root up the ground and prepare it for seed, but at all other times they should be kept out. Sheep and goats should be allowed in the forest only to clean up brush to make room for desirable seedlings. If good species are already growing, the owner should cut out the brush instead.

Western Forests

In the ponderosa pine and other naturally open forests of the West, a reasonable number of cattle, horses, and sheep can be grazed during suitable seasons. As long as there are abundant palatable grasses and other forage the livestock will not damage young pines.

Southern Forests

Hardwoods in the South as elsewhere are badly damaged by grazing. Moderate cattle grazing among the pines, especially in the Coastal Plain, when the forage is palatable, will reduce fire hazards and make possible added profits. Hogs, sheep, goats, and horses should be kept out.

Very young planted pines, or those coming up from seeds should be protected from all livestock. Cattle, horses, sheep, and goats often eat and trample the little trees. Hogs cause great damage to longleaf seedlings and even to larger trees by chewing the roots and upsetting the trees. Pines over 6 inches in diameter at breast height usually are not hurt much unless grazing is so heavy that stock trample or wound the trees or pack the ground.

To longleaf pine, the razorback hog is even more deadly than fire is. Heaviest losses are in trees 2 to 5 years old, but much older trees are often seriously injured or killed. Where there are razorbacks, young longleaf stands must be protected by a hogproof fence.

OTHER PROTECTION

Careful logging avoids damage to standing trees. Loggers should also locate and drain roads and skid trails so that they will not encourage erosion. Brush and limbs can be thrown on slopes where

the soil is unstable. Light cutting is also in order in such places. Any erosion in the forest should make the owner suspect that he is cutting too heavily. Where small areas have been cut clear a little soil may shift, but good management will speedily stop such movement.

A forest floor dried by wind and sunlight is another sign of too heavy cutting. Such soil may erode later. A border of low trees or shrubs around the outer edge of the forest keeps out drying winds.

If stands of northern hardwoods are cut too heavily, many of the remaining trees, especially birch, sugar maple, and hemlock, will die of the sudden exposure. Thus not over half of the salable timber should be cut at one time from mature or overmature stands of this kind. Hemlock should be taken either clear or in very light cuts.

Stands of northern hardwood saplings should be kept fairly dense for mutual support against ice and snow as well as to develop clear lengths of logs.

MEASURING THE FOREST

A good measuring job is the first step to a good sale. Before he can make a fair bargain the owner must know how much he has to sell. This section tells how to measure saw timber and other forest products. It also describes the general specifications of the different timber products so that the owner can size up his forest to see what he can make from it. This is useful to know, for sometimes one product is more profitable than another.

INTEGRATED USE

Each tree should be made up into the product or products that will bring the most profit. For example, one tree might yield one or two high-grade sawlogs from the butt, two or three cross ties from the smaller, rougher part of the trunk, and perhaps a length of pulpwood and some firewood from the top. Foresters call this "integrated utilization." When the forest owner does his own cutting instead of selling standing trees (called stumpage) he is said to be marketing *converted timber products.*

Since commercial operators seldom want to handle more than one product at a time, integrated cutting is generally done either by the forest owner himself or under his close supervision. It must be done with care if each tree is to be cut up properly. Furthermore, the man who supervises the job—often the owner himself—must learn to look at a standing tree and be able to tell what products it will make. If he cuts the trees himself the owner may have to buy a little extra equipment. Thus, before he actually starts to cut, he should be sure that his profits from integrated use will be greater than if he marketed his timber as only one product—sawlogs, perhaps.

Generally several cuttings are made. In hardwood forests, the buyer or the owner usually takes out sawlogs or veneer blocks first. He might cut slack cooperage blocks or cross ties next, and finally make pulpwood and fuel from the tops. In pine stands, the poles

or piling are harvested first, then the sawlogs. Sometimes a few cross ties can also be made. A pulpwood cutting may follow any of these steps, but is generally left for a last clean-up job. Material to be salvaged from the tops should be moved fast, especially in summer cutting, to avoid loss from stain, rot, or insects.

Caution.—Be sure that these repeated cuttings don't thin out your forest too much. (See pages 5 and 32).

MEASURING AND GRADING SAWLOGS

Posts, ties, and some mine timbers and poles are sold by the piece; hence it is easy to figure their value. Mine timbers, poles, and piling are measured by running foot of length. Here price per foot multiplied by length in feet gives the sale price. Pulpwood and firewood are sold in easily counted cords, pens, or units.

Sawlogs and some veneer blocks, however, are sold by the number of board feet they contain, and this is usually figured before the log is sawed and sometimes before the tree is cut down. (A board foot is equal to a piece of lumber 1 inch thick, 12 inches wide, and 12 inches long. A board 1 inch thick, 12 feet long, and 4 inches wide contains 4 board feet.) It is harder to measure logs than most other timber products, but with a little practice it can be done very satisfactorily.

Measuring Logs

Only a yardstick or ruler and the tables on pages 34 to 36 are needed to measure a log that has been felled and bucked. There are three steps:

1. Measure the average diameter of the log in inches, *inside the bark at the small end.* (If the log is fairly round measure across it only once. If it is uneven take the average of the short and long diameters.)
2. Measure the length of the log to the nearest foot, dropping all fractions and allowing 2 or 3 inches for trimming.
3. Find its contents by the table on page 34. Suppose it is 13 inches in diameter at the small end and 16 feet long. Run down the left-hand column (diameter) to the figure 13. Move across to the 16-foot column. The figure there is the estimated number of board feet that can be sawed from the log, in this case, 81.

This table uses the Doyle log scale, which is much used in this country, especially in the South. Its values are too low, though, for logs under 28 inches in diameter. The International scale, table 2, is more accurate and its use is increasing, but only a good sawyer will get full International scale value from a log. Notice that it estimates our imaginary log at 115 board feet. The Scribner decimal C rule, table 3, is used in our national forests and elsewhere.

The local forester will know which log rule is legal in any given State. Often buyer and seller may agree on their own scale when making out a contract.

A log-scale stick, with board-foot contents for various log lengths and diameters marked upon it, is handy when many logs are to be scaled. So that it will not be measured twice, each log should be marked with chalk after being scaled.

TABLE 1.—*The contents of logs, in board feet, by the Doyle log rule*[1]

Diameter of log small end, inside bark (inches)	Contents, according to length of log in feet												
	6	7	8	9	10	11	12	13	14	15	16	17	18
	Bd.ft.	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*
6	1	2	2	2	2	3	3	3	3	4	4	4	4
7	3	4	4	5	5	6	7	7	8	8	9	10	10
8	6	7	8	9	10	11	12	13	14	15	16	17	18
9	9	11	12	14	16	17	19	20	22	23	25	27	28
10	13	16	18	20	22	25	27	29	31	34	36	38	40
11	18	21	24	28	31	34	37	40	43	46	46	52	55
12	24	28	32	36	40	44	48	52	56	60	64	68	72
13	30	35	40	46	51	56	61	66	71	76	81	86	91
14	37	44	50	56	62	69	75	81	87	94	100	106	112
15	45	53	60	68	76	83	91	98	106	113	121	129	136
16	54	63	72	81	90	99	108	117	126	135	144	153	162
17	63	74	84	95	106	116	127	137	148	158	169	180	190
18	73	86	98	110	122	135	147	159	171	184	196	208	220
19	84	98	112	127	141	155	169	183	197	211	225	239	253
20	96	112	128	144	160	176	192	208	224	240	256	272	288
21	108	126	144	163	181	199	217	235	253	271	289	307	325
22	121	142	162	182	202	223	243	263	283	304	324	344	364
23	135	158	180	203	226	248	271	293	316	338	361	384	406
24	150	175	200	225	250	275	300	325	350	375	400	425	450
25	165	193	220	248	276	303	331	358	386	413	441	469	496
26	181	212	242	272	302	333	363	393	423	454	484	514	544
27	198	231	264	298	331	364	397	430	463	496	529	562	595
28	216	252	288	324	360	396	432	468	504	540	576	612	648
29	234	273	312	352	391	430	469	508	547	586	625	664	702
30	253	296	338	380	422	465	507	549	591	634	676	718	760
31	273	319	364	410	456	501	547	592	638	683	729	775	820
32	294	343	392	441	490	539	588	636	686	735	784	833	882
33	315	368	420	473	526	578	631	683	736	788	841	894	946
34	337	394	450	506	562	619	675	731	787	844	900	956	1,012
35	360	420	480	541	601	661	721	781	841	901	961	1,021	1,081
36	384	448	512	576	640	704	768	832	896	960	1,024	1,088	1,152
37	408	476	544	613	681	749	817	885	953	1,021	1,089	1,157	1,225
38	433	506	578	650	722	795	867	939	1,011	1,084	1,156	1,228	1,300
39	459	536	612	689	766	842	919	995	1,072	1,148	1,225	1,302	1,378
40	486	567	648	729	810	891	972	1,053	1,134	1,215	1,296	1,377	1,458

[1] To find the number of board feet in a 16-foot log according to the Doyle scale, subtract 4 from the diameter (in inches) of the small end of the log. Multiply the remainder by itself. This gives the contents of the log (in board feet). An 8-foot log would have half as many board feet, a 12-foot log three-fourths as many.

Scaling sound logs is fairly simple. Making deductions for defects, however, can only be learned through practice and by watching experienced scalers work. Much can be learned by carefully watching how a good sawyer saws up defective logs. A defect is some flaw that lowers the amount or the quality of the lumber that the log will produce. Common defects are rot, shake, check, pitch ring, cat faces, ingrown bark, worm holes, crooks or bends,

and crotches or forks. Hardwoods may suffer from blackheart and mineral streak. Spiral grain may be a defect in softwoods intended for high-quality lumber. Some defects are usually allowed in each grade, but first-grade logs will have none or only a few small ones. The scaler estimates how much wood the defect will waste and subtracts it from what the log would saw out if it were sound.

TABLE 2.—*The contents of logs, in board feet, by the International log rule, using saw cutting ¼-inch kerf*

Diameter of log small end, inside bark (inches)	Contents, according to length of log in feet												
	8	9	10	11	12	13	14	15	16	17	18	19	20
	Bd.ft.	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*
6	10	10	10	10	15	15	15	20	20	20	25	25	25
7	10	15	15	15	20	20	25	25	30	30	35	35	40
8	15	20	20	25	25	30	35	35	40	40	45	50	50
9	20	25	30	30	35	40	45	45	50	55	60	65	70
10	30	35	35	40	45	50	55	60	65	70	75	80	85
11	35	40	45	50	55	65	70	75	80	85	95	100	105
12	45	50	55	65	70	75	85	90	95	105	110	120	125
13	55	60	70	75	85	90	100	105	115	125	135	140	150
14	65	70	80	90	100	105	115	125	135	145	155	165	175
15	75	85	95	105	115	125	135	145	160	170	180	190	205
16	85	95	110	120	130	145	155	170	180	195	205	220	235
17	95	110	125	135	150	165	180	190	205	220	235	250	265
18	110	125	140	155	170	185	200	215	230	250	265	280	300
19	125	140	155	175	190	205	225	245	260	280	300	315	335
20	135	155	175	195	210	230	250	270	290	310	330	350	370
21	155	175	195	215	235	255	280	300	320	345	365	390	410
22	170	190	215	235	260	285	305	330	355	380	405	430	455
23	185	210	235	260	285	310	335	360	390	415	445	470	495
24	205	230	255	285	310	340	370	395	425	455	485	515	545
25	220	250	280	310	340	370	400	430	460	495	525	560	590
26	240	275	305	335	370	400	435	470	500	535	570	605	640
27	260	295	330	365	400	435	470	505	540	580	615	655	690
28	280	320	365	395	430	470	505	545	585	625	665	705	745
29	305	345	385	425	465	505	545	590	630	670	715	755	800
30	325	370	410	455	495	540	585	630	675	720	765	810	855
31	350	395	440	485	530	580	625	675	720	770	820	870	915
32	375	420	470	520	570	620	670	720	770	820	875	925	980
33	400	450	500	555	605	660	715	765	820	875	930	985	1,045
34	425	480	535	590	645	700	760	815	870	930	990	1,050	1,110
35	450	510	565	625	685	745	805	865	925	990	1,050	1,115	1,175
36	475	540	600	665	725	790	855	920	980	1,045	1,115	1,180	1,245
37	505	570	635	700	770	835	905	970	1,040	1,110	1,175	1,245	1,315
38	535	605	670	740	810	885	955	1,025	1,095	1,170	1,245	1,315	1,390
39	565	635	710	785	855	930	1,005	1,080	1,155	1,235	1,310	1,390	1,465
40	595	670	750	825	900	980	1,060	1,140	1,220	1,300	1,380	1,460	1,540

TABLE 3.—*The contents of logs, in board feet, by the Scribner decimal C log rule*

Diameter of log small end, inside bark (inches)	Contents, according to length of log in feet											
	8	9	10	11	12	13	14	15	16	17	18	20
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
6	5	5	10	10	10	10	10	10	20	20	20	20
7	10	10	10	20	20	20	20	20	30	30	30	30
8	10	10	20	20	20	20	20	20	30	30	30	30
9	20	20	30	30	30	30	30	30	40	40	40	40
10	30	30	30	30	30	40	40	50	60	60	60	70
11	30	30	40	40	40	50	50	60	70	70	80	80
12	40	40	50	50	60	60	70	70	80	80	90	100
13	50	50	60	70	70	80	80	90	100	100	110	120
14	60	60	70	80	90	90	100	110	110	120	130	140
15	70	80	90	100	110	120	120	130	140	150	160	180
16	80	90	100	110	120	130	140	150	160	170	180	200
17	90	100	120	130	140	150	160	170	180	200	210	230
18	110	120	130	150	160	170	190	200	210	230	240	270
19	120	130	150	160	180	190	210	220	240	250	270	300
20	140	160	170	190	210	230	240	260	280	300	310	350
21	150	170	190	210	230	250	270	280	300	320	340	380
22	170	190	210	230	250	270	290	310	330	350	380	420
23	190	210	230	260	280	310	330	350	380	400	420	470
24	210	230	250	280	300	330	350	380	400	430	450	500
25	230	260	290	310	340	370	400	430	460	490	520	570
26	250	280	310	340	370	410	440	470	500	530	560	620
27	270	310	340	380	410	440	480	510	550	580	620	680
28	290	330	360	400	440	470	510	540	580	620	650	730
29	310	350	380	420	460	490	530	570	610	650	680	760
30	330	370	410	450	490	530	570	620	660	700	740	820
31	360	400	440	490	530	580	620	670	710	750	800	890
32	370	410	460	510	550	600	640	690	740	780	830	920
33	390	440	490	540	590	640	690	730	780	830	880	980
34	400	450	500	550	600	650	700	750	800	850	900	1,000
35	440	490	550	600	660	710	770	820	880	930	980	1,090
36	460	520	580	630	690	750	810	860	920	980	1,040	1,150
37	510	580	640	710	770	840	900	960	1,030	1,090	1,160	1,290
38	540	600	670	730	800	870	930	1,000	1,070	1,130	1,200	1,330
39	560	630	700	770	840	910	980	1,050	1,120	1,190	1,260	1,400
40	600	680	750	830	900	980	1,050	1,130	1,200	1,280	1,350	1,500

Grading Logs

The grade of a log depends on its diameter and length and on the number and kind of its defects. Within each grade, the larger logs are the most valuable. Sometimes the amount of heartwood also counts.

Not every defect lowers a log grade. Generally speaking, however, grade 1 logs must be free of all serious defects, must meet certain length and diameter specifications, and must saw out a

specified amount of clear lumber. Lower grade logs may have one or more serious defects, may perhaps be shorter or thinner, and in general produce less salable lumber. Logs so full of flaws that it does not pay to saw them are called culls.

At present grading is complicated. Systems differ throughout the country not only with the kinds of trees and the products to be made from them, but also with individual mills. Prices of course depend on grades, a grade 1 sawlog being worth several times as much as a lower grade log of the same size.

If he can sell his logs by grade the owner is likely to make more money than if he sells ungraded. Thus, to prevent misunderstanding it would be very desirable to have standard, well-understood grades. In their absence, however, the inexperienced timber owner must rely on his local forester for help with grading. The forester will also know what mills pay best prices for the grade of timber the owner has to sell.

ESTIMATING STANDING TIMBER

Finding the volume of a standing tree accurately is not quite as easy as measuring it after it is felled and bucked. Often the owner can wait until then to measure it, especially if he does the logging himself. When he wants to sell stumpage or get bids, though, he must know how much standing timber he has. Buyers, of course, will want to pay according to their own estimate of the volume of the standing timber. The owner should be able to make an independent estimate in order to make a fair deal.

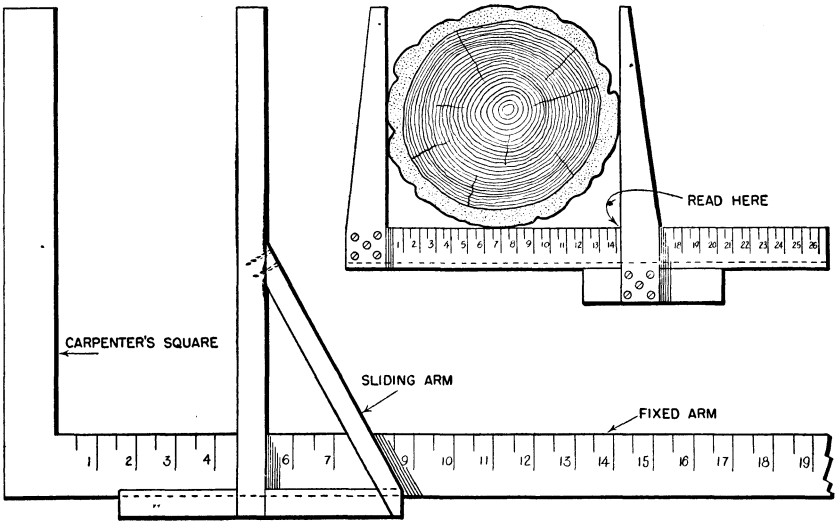

FIGURE 18.—Home-made calipers for measuring the diameters of trees.

Volume tables like those on pages 41 and 42 show approximately the number of board feet in a tree and greatly simplify estimating. To use the tables:

1. With a ruler, carpenter's square, or home-made calipers like those in figure 18, find the diameter of the tree in inches, outside the bark, breast high (4½ feet above ground).

2. Look at the tree and decide how many 16-foot logs it contains. This takes practice. A helpful home-made device is shown in figure 19.

3. Using table 4 or table 5, find the diameter of the tree in the left-hand column and move across to the column headed by the number of logs in the tree. A 20-inch tree with a merchantable length of 40 feet (2½ logs) would contain 370 board feet by the International rule (table 4).

The figures in these tables are averages from actual measurements of many trees. Used to find the volume of one or a few trees, the tables are not very accurate, but as more trees are measured the table figures are increasingly accurate.

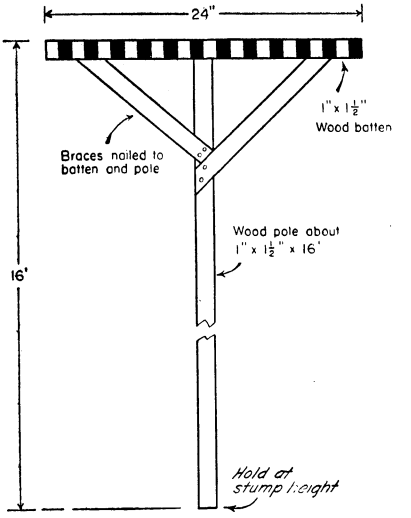

FIGURE 19.—A home-made height scale. (Crosspiece is optional and used to estimate the diameter at the top of the first 16-foot log.)

Timber-scaling sticks, about which the local forester will have information, are another way of measuring standing timber.

Diameter of tree breast-high (inches)	Shortleaf pine				Loblolly pine				White oak				Black oak				Hickory							
	1-log	2-log	3-log	4-log	1-log	2-log	3-log	4-log	1-log	2-log	3-log	4-log	1-log	2-log	3-log	4-log	1-log	2-log	3-log	4-log	1-log	2-log	3-log	4-log
8																								
10																								
12																								
14																								
16																								
18																								
20																								

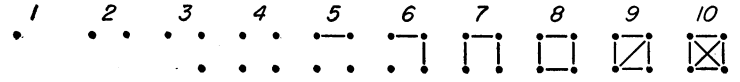

FIGURE 20.—Sample tally sheet for tallying trees when volume tables are available, and the dot and line method of tallying by tens.

Making a Cruise

A timber cruise is an estimate of the timber to see what kind of trees are growing, how many are marketable, and so on. The trees can be estimated either at the same time that they are marked for cutting or later.

The estimator should make and take with him a tally sheet something like the one in figure 20. Whenever he estimates a tree he can put a tally in the proper square. A good way is to tally by tens, using a dot apiece for the first four trees and connecting lines for the next six as shown in figure 20. Then, when his cruise is finished, he can figure up the amount of timber represented by every square of the tally sheet and add the sums of all the squares. If his tally is only a sample of the forest he will of course have to make due allowances.

Making an Estimate from a Sample

When his time is short or his forest large, the owner may have to judge the volume of his whole stand by the part of it which he has time to measure. The important thing then is to get a fair sampling, neither better nor worse than the rest of the forest. The larger the sample the more accurate it is. In small woodlands, however, it is best to measure every tree directly.

On forests of 50 to 100 acres the most desirable way of sampling is probably to count and mark the trees to be sold and keep a record of every tenth tree. Multiplying the total volume of the samples by 10 gives the estimated volume of the entire stand.

Another way of sampling is to lay out plots at regular distances and measure the volume of the merchantable trees on the plots. In a 60-acre forest, the owner might lay out 60 quarter-acre plots, measure the salable timber on them, and multiply the total by 4.

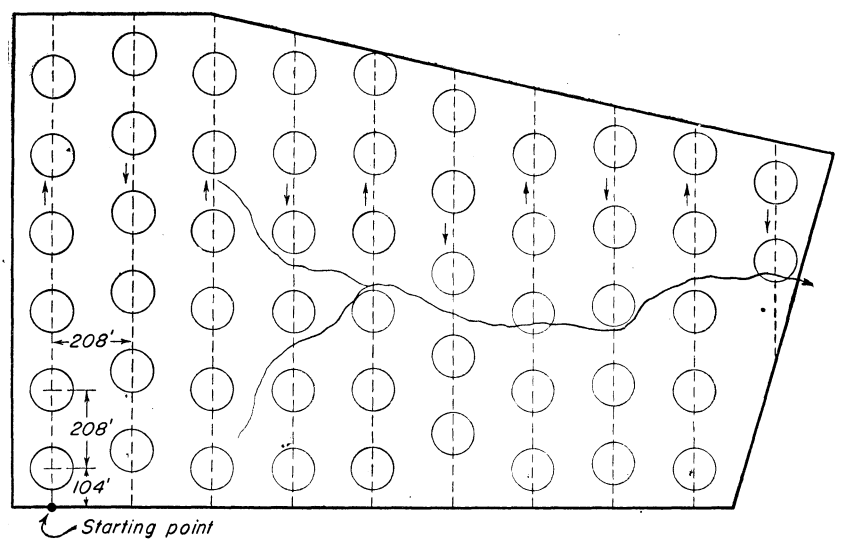

FIGURE 21.—Plot method of estimating timber.

Samples of a quarter or a fifth of an acre in size are easier to measure than larger plots, and, since more of them are used, are probably more accurate. One acre is 208 feet square. A quarter of an acre is 104 feet square, or, if round, 118 feet in diameter. Round plots are usually easier to estimate than square ones.

Plots can be paced off. The owner of the tract shown in figure 21 made 10 trips across it, each trip and each sample on each trip being 208 feet apart. His paces averaged 2½ feet in length; thus every eighty-third step marked the center of a sample plot, where he stopped and measured. When he had finished, his tally sheets showed 12,000 board feet of timber on 52 quarter-acre samples. This was the same as 12,000 board feet on 13 acres, or about 920 board feet per acre. He knew that the forest contained 55 acres, and so he figured that he had about 50,600 board feet of merchantable timber.

In the strip method of sampling, used on larger forest lands, a strip 66 feet wide is run across the forest, and every merchantable tree in the strip is estimated. A strip 66 feet wide and 660 feet long measures 1 acre; at the end of each 660-foot stretch, then, a new tally sheet is begun. Spacing the centerline of the 66-foot strips 264 feet apart will measure a quarter of the woods; 132-foot spacing half of it. Two men are needed. The tallyman walks along the centerline of the strip and the caliper man calls out the species, diameter, and height of each merchantable tree to him. When they reach the edge of the forest they move over 264 feet (if they are measuring a quarter of the forest), and run another 66-foot strip back. See figure 22.

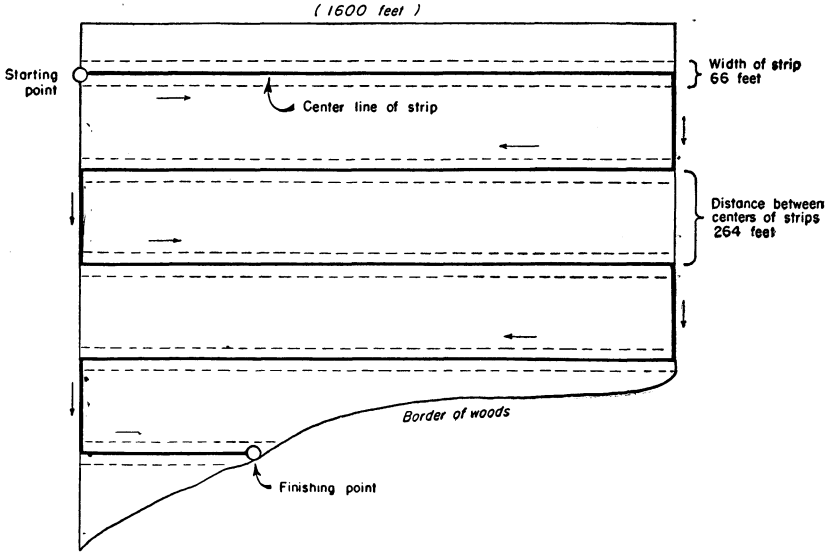

FIGURE 22.—Strip method of estimating a stand of timber.

TABLE 4.—*Amount of saw timber in trees, by diameter and merchantable height International ¼-inch rule*

Diameter of tree, breast-high (inches)	Volume (board feet) according to number of usable 16-foot logs										
	1	1½	2	2½	3	3½	4	4½	5	5½	6
10	39	51	63	72	80						
11	49	64	80	92	104						
12	59	78	98	112	127	136	146				
13	71	96	120	138	156	168	181				
14	83	112	141	164	186	201	216				
15	98	132	166	194	221	240	260				
16	112	151	190	223	256	280	305				
17	128	174	219	258	296	325	354				
18	144	196	248	292	336	369	402				
19	162	222	281	332	382	420	457				
20	181	248	314	370	427	470	512	546	580		
21	201	276	350	414	478	526	575	616	656		
22	221	304	387	458	528	583	638	685	732		
23	244	336	428	507	586	646	706	761	816		
24	266	368	469	556	644	708	773	836	899		
25	290	402	514	610	706	779	852	922	992		
26	315	436	558	662	767	849	931	1,008	1,086		
27	341	474	606	721	836	925	1,014	1,100	1,185		
28	367	510	654	779	904	1,000	1,096	1,190	1,284	1,368	1,453
29	396	551	706	842	977	1,080	1,184	1,289	1,394	1,491	1,588
30	424	591	758	904	1,050	1,161	1,272	1,388	1,503	1,613	1,723
31	454	634	814	973	1,132	1,254	1,376	1,497	1,618	1,740	1,862
32	485	678	870	1,042	1,213	1,346	1,480	1,606	1,733	1,867	2,001
33	518	724	930	1,114	1,298	1,442	1,586	1,722	1,858	2,005	2,152
34	550	770	989	1,186	1,383	1,537	1,691	1,838	1,984	2,144	2,304
35	585	820	1,055	1,266	1,477	1,642	1,806	1,965	2,124	2,291	2,458
36	620	870	1,121	1,346	1,571	1,746	1,922	2,093	2,264	2,438	2,612
37	656	922	1,188	1,430	1,672	1,858	2,044	2,230	2,416	2,600	2,783
38	693	974	1,256	1,514	1,772	1,970	2,167	2,368	2,568	2,761	2,954
39	732	1,031	1,330	1,602	1,874	2,087	2,300	2,507	2,714	2,920	3,127
40	770	1,086	1,403	1,690	1,977	2,204	2,432	2,646	2,860	3,080	3,300

Data from Mesavage and Girard, tables for estimating board-foot volume of timber. (Form class 80.) U. S. Department of Agriculture, Forest Service. 1946.
For exceptionally tall, slender trees add 10 percent.
For exceptionally short, stubby trees deduct 10 percent.

TABLE 5.—*Amount of saw timber in trees, by diameter and merchantable height Doyle log rule*

Diameter of tree, breast-high (inches)	Volume (board feet) according to number of usable 16-foot logs										
	1	1½	2	2½	3	3½	4	4½	5	5½	6
10	16	20	23	24	26						
11	24	30	35	38	42						
12	31	39	47	52	57	60	62				
13	42	53	64	72	80	84	88				
14	52	67	82	93	104	109	114				
15	64	84	104	118	132	141	150				
16	77	101	125	143	161	174	186				
17	92	122	152	175	198	214	230				
18	108	144	179	206	234	254	273				
19	126	168	210	244	278	301	324				
20	144	193	242	282	321	348	374	396	417		
21	164	221	278	324	370	403	436	462	489		
22	185	250	315	368	420	458	497	529	561		
23	208	282	356	417	478	521	564	604	643		
24	231	314	397	466	536	583	630	678	725		
25	256	350	443	522	600	655	710	764	818		
26	282	386	489	576	663	727	791	852	912		
27	310	425	540	638	735	806	877	946	1,015		
28	339	466	592	700	807	885	963	1,040	1,118	1,188	1,258
29	370	509	648	766	884	970	1,056	1,144	1,232	1,315	1,398
30	400	552	703	832	961	1,055	1,149	1,248	1,346	1,442	1,537
31	434	599	764	906	1,049	1,154	1,260	1,364	1,469	1,576	1,684
32	467	646	824	980	1,137	1,254	1,370	1,481	1,592	1,712	1,831
33	502	696	889	1,060	1,230	1,356	1,483	1,604	1,726	1,860	1,994
34	538	746	954	1,138	1,322	1,459	1,596	1,728	1,861	2,008	2,156
35	576	801	1,026	1,225	1,424	1,573	1,722	1,867	2,012	2,167	2,322
36	615	857	1,099	1,312	1,526	1,688	1,849	2,006	2,163	2,326	2,488
37	656	915	1,174	1,406	1,638	1,811	1,984	2,157	2,330	2,502	2,675
38	697	973	1,249	1,499	1,749	1,934	2,119	2,308	2,496	2,679	2,862
39	740	1,036	1,332	1,598	1,864	2,065	2,266	2,462	2,658	2,855	3,052
40	784	1,099	1,414	1,696	1,979	2,196	2,413	2,616	2,819	3,030	3,241

Data from Mesavage and Girard, tables for estimating board-foot volume of timber. (Form class 80.) U. S. Department of Agriculture, Forest Service. 1946.

For exceptionally tall, slender trees add 10 percent.

For exceptionally short, stubby trees deduct 10 percent.

VENEER LOGS

Veneer logs are scaled in about the same way as sawlogs. However, surface defects are very serious, while small center flaws often matter little. Mills take logs of various lengths, some as short as 2 feet. Specifications change so often that before cutting his logs the owner should find out what sizes the buyer wants.

Logs for basket, crate, and box veneer should be clear, straight, sound, and of the right size. Usually there are only 2 or 3 grades. The price is lower and the price range is narrower than for fancy veneer logs, but poorer material and smaller sizes are taken.

Fancy veneer logs or bolts for fine furniture veneer should most of all have a clear surface and be straight and sound. Grades depend also on size, amount of sapwood, and, sometimes, figure. Individual plants have their own specifications. Prices range widely with grades, but poor or small stuff is usually not wanted.

Yellow birch, maple, yellow-poplar, black cherry, beech, elm, cottonwood, sycamore, sweet (red) and black gum, tupelo, black walnut, basswood, and oak are some of the most common veneer woods.

POLES AND PILING

A given tree may bring more money if it can be made into high-quality poles or piling than if it is cut into shorter products or even into saw timber. Southern pines treated against decay, together with eastern white-cedar, furnish most of the southern and eastern pole timber. Many other species yield good posts and piling. Douglas-fir, southern yellow pine, and oak are used where great strength is needed.

Poles must usually be of best quality, butt cut, square at both ends, fairly straight, well-proportioned from top to butt, and peeled. Knots must be trimmed close. Defects are crookedness, split tops and butts, rot, checks, and shakes.

Pole and piling specifications vary so much that before cutting the owner should know exactly what sizes the buyer will take.

Piling is graded by form and size. Piles should have knots trimmed close, and should be sound, peeled, and free from defects that lower their strength or durability. They should have no short crooks. A straight line from the center of the butt to the center of the top may lie outside the body of the pile, but not by more than ½ of 1 percent of the length of the pile. Piling sells by running foot for specified sizes and kinds of wood. The price rises rapidly for longer piles of good shape. Most piles must be at least 6 inches in diameter at the top. They are classified by size 3 feet from the butt and by top measurement.

PULPWOOD

The forest owner who wishes to cut pulpwood should get specifications from his local forester or from the buyer. Requirements vary widely with the different mills. Pulpwood is used for making paper, rayon or other chemical products, pulpboard, and wallboards.

Pulpwood is sold anywhere from the stump to the pulp mill. Some owners sell stumpage directly to company agents or to contractors, who often cut the wood. Others sell pulpwood loaded

on the railroad car. In this case it is measured as stacked on the car, usually after delivery to the plant. For the owner who sells delivered to the railroad siding, the wood is either measured on the truck before unloading or when piled on the ground.

Pulpwood is measured in pens, standard cords, or units (fig. 23). Units are sometimes called "long cords." Pens are layers of two sticks piled to form a hollow crib about 6 feet high. A standard cord is a stack of 4-foot-long pulpwood piled 4 feet high and 8 feet across the front, equal to 128 cubic feet. Allowing for air spaces, it contains about 90 cubic feet of solid pulpwood and bark. It is common practice to stack green wood 3 or 4 inches higher than the required 4 feet to allow for shrinkage.

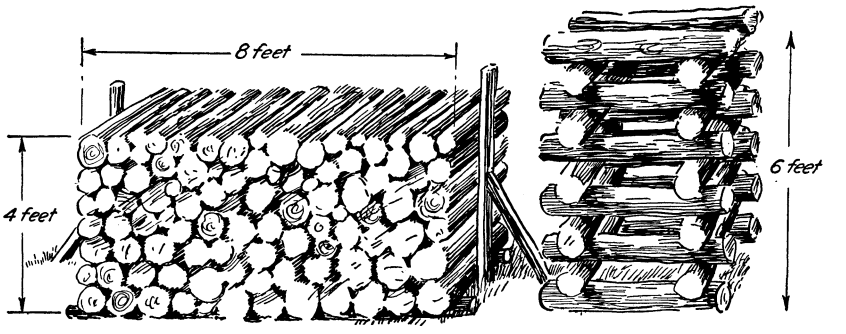

FIGURE 23.—Pulpwood measures—cord and pen.

Pulp mills now commonly buy wood in lengths from 4 feet 6 inches to 6 feet. A few mills want wood cut up to 8 feet. A stack of wood in any of these lengths piled 4 feet high and 8 feet across the front is called a unit. Because each stick is cut longer, these units are larger in size and have a greater volume of solid wood than the standard cord, as the following tabulation shows:

Size of unit, stacked (*feet*)	Volume of solid wood and bark (*cubic feet*)
4 x 4 x 8 (standard cord)	90
4 x 4½ x 8	102
4 x 5 x 8	113
4 x 5¼ x 8	119
4 x 6 x 8	136
4 x 8-1/3 x 8	181

Buyers usually take 5 pens of wood to equal 1 cord or 1 unit. If all the sticks are 6 inches in diameter, 5 pens of 4-foot wood will equal a standard cord or 1 unit for 5-foot wood. As the sticks become larger in diameter the number of cords or units increases. Five pens of 12-inch-diameter wood equal 2 cords or 2 units. Since pens are generally built up with sticks of varying diameters there is no accurate way for the seller to know how many cords or units 5 pens will equal. The woodland owner can readily see this is not a safe way to calculate the volume of pulpwood he has to sell. He should always measure it in standard cords or units.

The woodland owner can estimate the pulpwood in his standing trees in about the same manner as saw timber. He measures and counts the pulpwood trees, tallying them by usable pulpwood length in feet and by diameter. Then from figures such as those given in table 6 he can determine the number of cubic feet of solid wood each tree will yield. The forester will probably have a table that is more accurate for local conditions. The total volume in cubic feet of all trees to be cut can be changed into cords or units by dividing by the figures given in the tabulation above. For example, if the owner finds that his trees to be cut for pulpwood total 1,260 cubic feet of solid wood, he has 14 standard cords for sale, or slightly over 11 units of 5-foot wood.

TABLE 6.—*Average contents of trees in cubic feet, including bark, by usable length*[1] *and diameter*

Diameter of tree, breast high (inches)	Contents, according to usable length of tree in feet													
	12	16	20	24	28	32	36	40	44	48	52	56	60	64
	Cu.ft.	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*	*Cu.ft.*
6	1.6	2.2	2.7	3.2	3.8	4.3	4.8	------	------	------	------	------	------	------
8	2.8	3.6	4.6	5.5	6.4	7.3	8.3	9.1	10.1	11.0	------	------	------	------
10	4.1	5.4	6.8	8.2	9.5	10.8	12.3	13.6	14.9	16.3	17.7	19.0	20.4	------
12	5.8	7.6	9.4	11.2	13.0	14.9	16.7	18.6	20.5	22.3	24.2	26.0	27.9	29.8
14	------	------	------	------	16.8	19.3	21.7	24.0	26.5	28.9	31.3	33.7	36.1	38.5
16	------	------	------	------	------	23.8	26.9	29.8	32.8	35.8	38.8	41.7	44.7	47.7

[1] Estimated from stump to a top diameter of about 5 inches (varying from 3.8 to 6 inches).

TIES

Railroad ties should be sound, straight, and free of bark and weaknesses like large shakes and loose or decayed knots.

Class U ties (which do not need treatment to preserve the wood) are made from the heartwood of white oak, black locust, catalpa, chestnut, red mulberry, sassafras, redwood, pine, larch, cypress, cedar, and Douglas-fir. Class T (needing treatment) include ash, hickory, honeylocust, red oak, beech, birch, cherry, gum, hard maple, elm, hackberry, sycamore, butternut (white walnut), poplar, soft maple, true firs, hemlock, spruce, and the sapwood of all woods in class U. Sometimes other woods are accepted.

Standard-gage ties are either 8, 8½, or 9 feet long. There are five grades of ties, the highest grade (No. 5) being the largest. Grade 1 is a round-edge tie, 6 by 6 inches, hewed or sawed top and bottom, whereas grade 5 is 7 by 9 inches, sawed or hewed either on all four sides or only on the top and bottom.

Before cutting ties the forest owner should find out the buyer's specifications.

MINE TIMBERS

Mines buy many kinds and forms of timber besides much rough lumber. Ask the company for specifications.

Mine props are round timbers for supporting the roofs and sides of tunnels. They are from 4 to 14 inches in diameter and 3 to 12 feet long.

Lagging is round timber about 3 inches in diameter and 7 feet long, used to fill in behind the props and caps to form the sides and roofing of the tunnels. *Bars* are extra-long lagging.

Caps are hewed or sawed pieces of timber of different sizes laid across the tops of pairs of props as a support for the roof lagging, which runs lengthwise along the tunnel.

Sills, the foundations for props, are from 8 to 14 inches in diameter, either sawed or square-hewed.

Mine ties are ordinary track ties, 4 inches on the face and usually 3 to 5 feet long.

BOLTS AND BILLETS

Bolts are short lengths of log. Billets are bolts or short logs sawed or split lengthwise, as for handle and spoke blanks and cooperage blocks. (In the southern pine region these definitions are exactly reversed.) Splitting wastes much more of a bolt than sawing does.

Bolts and billets are used for cooperage, excelsior, woodenware, handles, and so on. Hickory goes into ax and hammer handles and spokes; and ash into hoe, rake, and shovel handles. Beech, birch, maple, and oak also make handles. Excelsior plants buy aspen, basswood, cottonwood, willow, southern pines, and yellow-poplar. Tight cooperage plants, making items like whiskey barrels, use hardly anything but white oak. Other kinds of barrel plants will buy basswood, ash, beech, birch, American elm, maple, and sweetgum. Each of these woodworking plants has its own specifications for the stock it will buy.

Bolts are measured and sold by the cord, the running foot, and especially if over 12 inches in diameter, by board measure. Billets are often sold by the piece, or may be stacked and sold as cords of standard or some other width.

FUEL WOOD

Firewood is also stacked and sold by the cord. As with pulpwood, the actual amount of wood in the pile depends on how large and straight the sticks are. In some sections fuel wood is sold in 12-, 16-, or 24-inch lengths, stacked 4 feet high and 8 feet long. Three piles of 16-inch wood contains more than one pile of 4-foot wood, however.

A standard cord of dry hickory, oak, beech, sweet birch, rock elm, hard maple, black locust, or longleaf pine (because it has so much resin) can give about as much heat as a short ton of high-grade coal or 200 gallons of domestic fuel oil. The heavier hardwoods weigh about 2 tons per cord. Cedar, redwood, poplar, cypress, basswood, spruce, and white pine give only about half as much heat—2 cords equal a ton of anthracite. Dry wood gives much more heat than green pieces. (See p. 54).

Making crowns and limbs and poor, dead, or surplus trees into fuel gives better trees room to grow and reduces the fire hazard. For this reason lumber companies are often glad to have limb and top wood gathered from their lands free of charge.

CUTTING THE TIMBER CROP

The owner of the small forest can often increase the income from his timber products by cutting, preparing, and hauling them himself, just as he does with his cotton, wheat, or other field crops. In this way he sells his labor and that of his team or machinery along with his timber.

If he does his own logging, he will naturally be more careful than a contractor to cut only the right trees, to avoid damage to young and standing trees, to prevent fire, and in general to make the best use of his woods. Furthermore, with few exceptions (pp. 28 and 53) the work can be done whenever there is time for it. It may even be a welcome change from regular tasks.

How much work the owner puts in depends on his products. Unless he knows something about it, though, he should probably keep out of the sawmill business. Generally too, it will not pay him to buy any expensive lumbering equipment unless he can also use it in his farm work or other business. If he has a large amount of timber to harvest in a short time he may consider buying a logging truck, but usually it will be cheaper to hire a trucker to do the hauling.

Most farmers skid and haul wood with their teams. Many have tractors or trucks that are useful in the woods. If they expect to harvest much timber, farmers buying new equipment should get it heavy enough to stand up to woods work.

Most small forest owners wisely cut their timber in the winter, when they may have spare time and help. Winter weather also protects the timber from insects, decay, and stain. Snow often aids skidding and hauling. In some sections markets are best when bad weather limits logging in inaccessible timber. Then too, buyers may take certain products only during specified seasons. Some mills, for example, take hardwood pulpwood only in winter. On the other hand, some products, like those that need peeling, can be handled best in summer.

If he plans summer cutting, the forest owner should be able to protect or move quickly any timber likely to be damaged by warm weather and the pests it brings.

TOOLS

Equipment for felling trees and making logs consists of an ax, a saw or two, a sledge hammer, wedges, measuring stick, and a bottle of kerosene for oiling the saw. A peavey is useful for moving logs and tree trunks. Power equipment such as chain saws and farm tractors are being used more and more in small woodlands.

Double-bitted axes, while dangerous to handle and carry, are usually preferred, since one blade can be used for materials that dull the edge quickly and the other saved for normal chopping. For trees less than 1½ feet in diameter, a 3-pound ax serves, but for larger timber a 3½- or 4-pound ax is better.

Saws 5½ or 6 feet long are about right for ordinary timber. A narrow saw with a concave back to make wedging easy works

well for small timber, but a straight-back saw is recommended for larger stock. Figure 24 shows the difference between the teeth of hardwood and softwood saws. The hardwood type is also used for mixed hardwoods and softwoods.

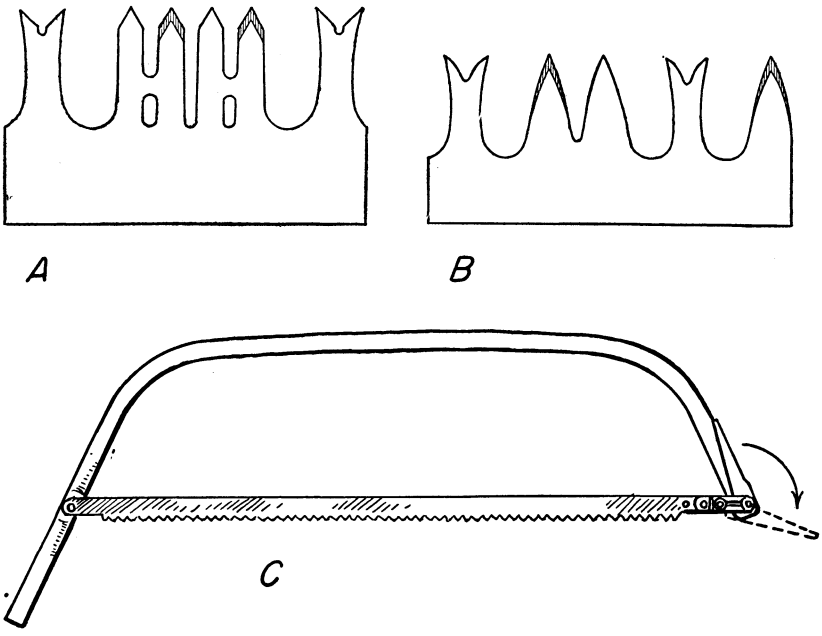

FIGURE 24.—Cutting edge of saws for softwood (A) and hardwood (B) and a bow saw (C).

For trees under 10 inches in diameter the frame or bow saw—a much stronger and faster form of the old bucksaw—will save a good deal of sawing labor (fig. 24). One man can use it to fell and buck trees for poles, ties, fuel, and so on. It is much used for making pulpwood.

A dragsaw, buzz saw, or some other sort of power saw saves much time when bucking is a big part of the job, as for pulpwood or fuel.

Tough, shock-resisting woods like dogwood, persimmon, gum, hickory, ash, beech, birch, maple, or oak make good wedges, as does steel or iron. Wedges are about 4 inches wide by 7 long and have an ax-blade taper.

HANDLING SAWLOGS

Felling

No man should go into his forest with an ax and saw unless he has already been there to mark the trees he wants to cut. As explained on page 11, unless marking is done first and separately, some trees are bound to be cut that should have been left to grow.

First of all, the workman may have to clear away just enough of the young trees to allow him to work freely at the tree he wants

to fell. He should plan to drop the tree in natural openings in the forest, if possible. At any rate it should not catch in another tree, should do the least possible damage to itself and to other trees in falling, and should be easy to work with after it is down. Trees felled with crown uphill may suddenly slide back.

Stumps should be low—6 to 8 inches on trees up to 20 inches in diameter at breast height. Bigger trees should be taken a foot or less above ground. Higher stumps waste lumber and get in the way during skidding and other operations.

To fell the tree, start the undercut (fig. 25) on the side toward which the tree should fall. On a straight tree, the undercut should be chopped out to about one-third of the diameter and should have a level bottom. The main saw cut starts on the opposite side of the tree, slightly above the level of the bottom of the undercut. When the saw blade binds, drive in a wedge to free it. When the cut is almost through, saw fast in order to cut as many wood fibers as possible. If the tree is not cut nearly clean off it may splinter badly.

Withdraw the saw and get out of the way quickly when the tree starts to drop. Falling limbs are very dangerous. Also, the trunk of the tree may kick back or bounce sidewise.

A tree that has caught in another while falling can sometimes be brought down by felling a third tree across it as close to the supporting tree as possible. Sometimes the grounded end of the hung tree can be pulled clear with a tractor or team on a long chain. A final but dangerous way is to fell the supporting tree with an ax according to the directions for leaning trees.

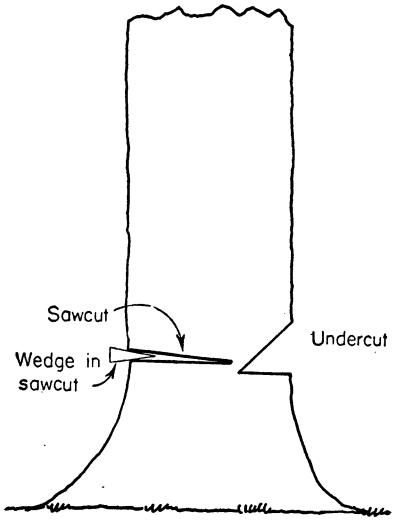

FIGURE 25.—Felling a straight tree.

Unbalanced or leaning trees should be chopped down, not sawed, in the direction in which they lean. If the undercut is carried well past the heart, a few cuts on the opposite side will bring the tree down. Deeply undercut trees are unlikely to split and kick back.

If a leaning or crooked tree has to be dropped in some other direction than it would naturally fall, undercut it on the side to which it is to go. Carry the undercut to the center. Then saw on the side of the natural fall up to the center, if possible. Remove the saw and wedge the cut strongly. Next, saw opposite the undercut until the tree weakens. Remove the saw and wedge the tree in the direction it should go.

Work safely and be *careful* at *all* times. Cutting tools are dangerous; a falling tree can cause injury or death.

Bucking

Sawing the felled tree into proper lengths is called bucking. The whole aim of good bucking is to separate the high-value sections from the poorer parts. Often good logs can be cut between major defects like knots and crooks, but cutting many short logs should be avoided. A very general rule for sawlogs is to cut as many 16-foot lengths as possible. However, each log must be bucked in its own way, always so as to get the best products and grades and quantities from the tree. The local forester will be able to guide inexperienced workers here as well as on other phases of logging.

Log lengths should be measured accurately, allowing 3 inches extra for trim. If the tree is likely to split when it is bucked it should be supported or rolled into a safe position. Branches should be lopped off even with the surface of the log. Large logs that must be ground-skidded are beveled or nosed on the small end. All brush should be pulled away from living trees to lessen the danger from fire and, in the southern pines, from beetles. In some regions slash may have to be burned. In others it can be lopped and spread out evenly to decay.

Skidding

A team or tractor will skid logs to a loading point. A single horse or mule is enough for light work like snaking out 20-inch logs for short distances (fig. 26). A chain is necessary. Grapple

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FIGURE 26.—Logs skid well in snow. To make the log slide easily, the horse is hitched to the small end.

hooks or tongs to be hooked to the clevis are very useful. The tongs are hooked on the end of the log, a little below center. Usually logs skid best small end first. In skidding on a slope teamsters should always walk on the uphill side of the log. Logs that run too freely endanger teams and drivers and should be braked by being wrapped with chains. Sometimes men with peavies can work them to safe levels if the logs are peeled on the running side and beveled at the small end. Wise lay-out of skid trails, running across instead of down steep slopes, will eliminate much trouble and reduce the danger of erosion as well.

Loading and Hauling

Logs may either be rolled onto trucks or wagons by manpower or crosshauled up by team or tractor. In either case two or three men are needed. For crosshauling, the log should lie parallel to the wagon or truck, 6 or 8 feet from the wheels. Two skid poles 6 inches thick and 6 or 8 feet long are placed so as to reach from the ground to the bolster of the truck or wagon (fig. 27). These skids should sit firmly in the ground at all times, or they will slip out and fall down when the log is being hauled up.

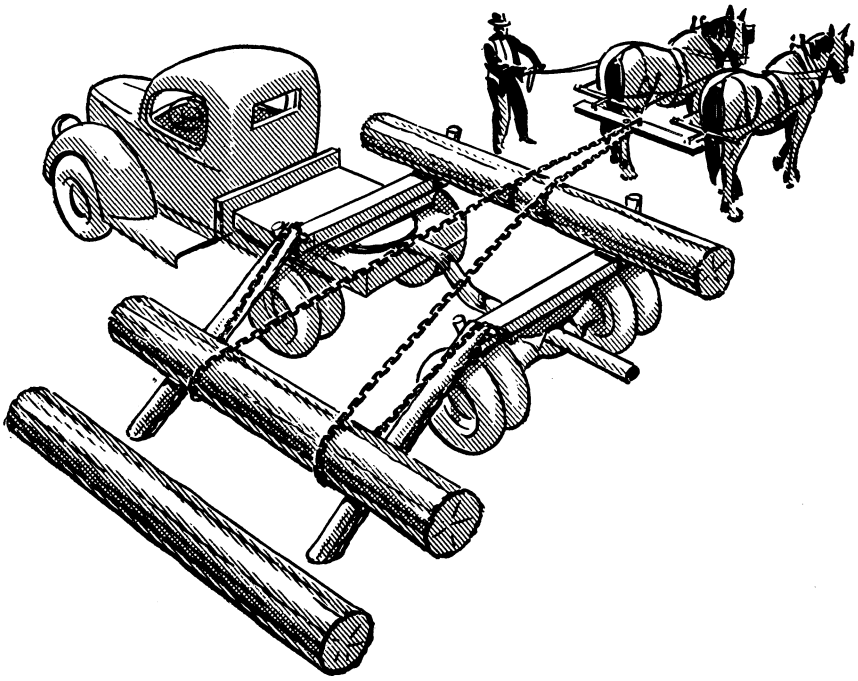

FIGURE 27.—Crosshauling.

A chain 3/8 inch or more in diameter and 30 or 40 feet long is also needed. Fasten one end of it to the front bolster and the other end to the rear bolster on the side from which the logs are to be loaded. Pass the middle part of the chain under the log to be loaded

and then back over it and the vehicle. Now a team or tractor hitched to the loop of chain will roll the log up the skids. Block the log if it is likely to roll off the other side of the truck. The chain rests on the top of the bolster or chock for the first layer and in a notch or fork in the end of the skids for the other layers. After the first layer is loaded, raise the skid poles to rest on the logs and move the chain so that it comes up between the two logs farthest from the skids. This will place the teamside log of the second layer in proper position. When the load is finished the free end of the chain can be used to bind the logs in place for the trip to the mill.

In hand loading, two or three men with peavies or cant hooks roll the logs from some sort of dock onto the truck (fig. 28).

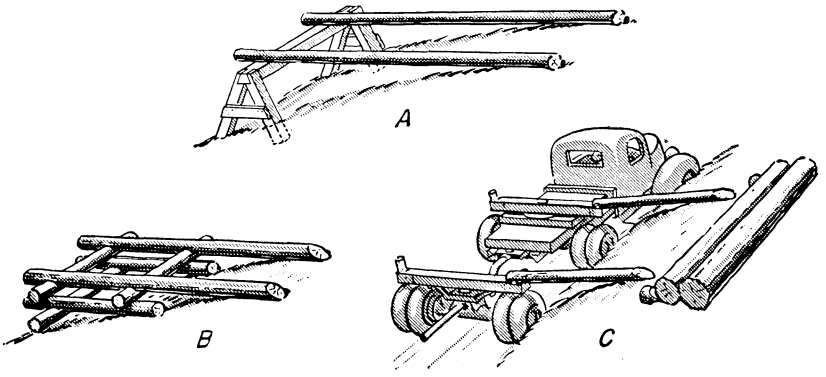

FIGURE 28.—Loading docks: *A*, Simple type for sloping ground; *B*, dock made by cribbing logs; *C*, bank used as dock.

Logs are hauled in any way that is convenient. In the North sleds work well. Wagons are satisfactory too. Trucks are being used more and more for long hauls.

CUTTING OTHER TIMBER PRODUCTS

Poles and piling are handled in much the same way as logs. Other products are harvested in different ways, depending on logging conditions, tools, equipment on hand, and, of course, on the specifications that the pieces must meet. In most cases common sense will suggest ways of doing the job, and experience will make the work easier and faster. A few hints on some tasks may help, though.

Peeling

Some products, like poles, piling, fence posts, and sometimes pulpwood must be peeled before being sold. Trees peel easiest for about 3 months in the spring and early summer after the hardwood leaves are fully out. At this time they should be peeled promptly after felling. Of course, the bark can be taken off at any other time of the year. Short stock can best be peeled before they are bucked, as the bark can then be pulled off in long strips.

Useful peeling tools are shown in figure 29. The flattened hoe works well. Its blade is slightly concave and the edge is smooth but not sharp. It is pushed lengthwise along the trunk of the tree.

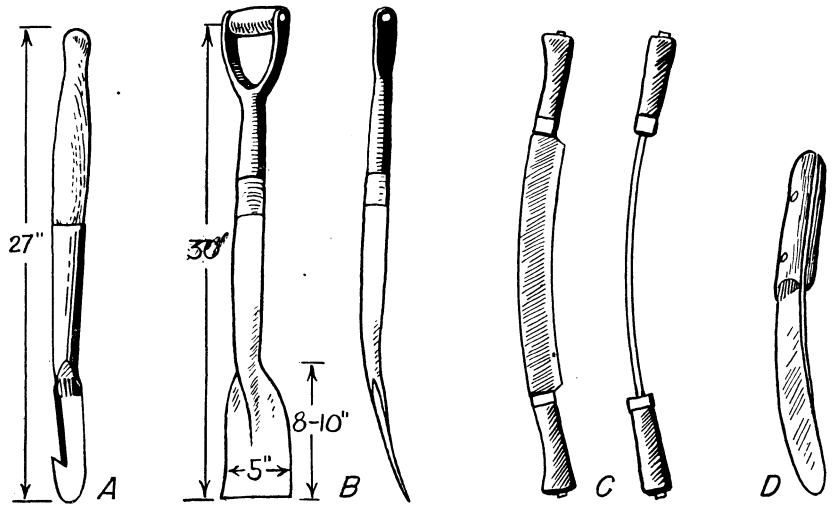

FIGURE 29.—Peeling tools: *A*, Hemlock spud; *B*, spud made from spade; *C*, timbershave; *D*, auto spring.

Some buyers have peeling machines for poles and piling. Mechanical peelers are being developed for fence posts. The local forester will know about them.

Making Ties

One man can make ties, but two naturally work faster. Besides a crosscut, frame or bow saw, wedges, an ax, broadax, and measuring stick are needed. Ties are often sawed square instead of hewed; sawing is faster and more accurate.

To hew a tie, mark off the bole into tie lengths and square up the faces. Beginners at hewing should mark guiding lines so that the two faces will be parallel (one-half inch of leeway is allowed). Next, stand on the bole and make slanting cuts 6 inches apart and as deep as the guide lines. Do this on both faces and for the full length of the piece; then smooth off the faces with the broadax. Well-hewed ties have even faces and no gashes over half an inch deep. If the ties must be squared, saw off the crown of the tree and square the other two sides in the same way. Then buck the bole into tie lengths. To make pole ties, peel the bark on the top side, turn the bole, and bark and buck it.

CARING FOR TIMBER PRODUCTS

Once timber has been felled, it must be protected from weather, drying, disease, and insects. For this and other reasons, it is very desirable to sell and deliver timber products as soon as possible after they are cut. When this is impossible, they should be stored safely. In summer blue stain may develop in 6 or 7 days, insect

and checking damage in a few weeks. Timber cut early in winter, however, may often be held into the following spring without damage. All these problems are more acute in the South than in the North.

Seasoning

As soon as a tree is cut down, it begins to lose its moisture. Because more air can get to it lumber seasons faster than logs, posts, and poles. All green timber, if it dries too slowly, is liable to be attacked by stain, rot, or insects. If it dries too fast it will check, split, crack, warp.

Sap or blue stain greatly affects the appearance, though not the strength, of lumber, and may cause down grading. Logs are often badly stained before sawing, but green lumber will stain easily too.

When the season is warm or damp, logs and other round timber should be quickly taken to a dry, well-aired, shady place and put on skids well off the ground. The most practical ways to prevent stain are to cut trees during dry, cool weather, and to move them quickly to market whenever they are cut. Foresters can recommend an end coating for logs that will prevent stain and checking, but this treatment is usually costly and may be impractical for owners of small forests. Logs and all other timber products may also be stored under water. If completely submerged, they need no further care.

Green fresh-sawed lumber kept for home use should be stacked for seasoning as soon as possible in some open, level, well-drained place. The stack should be well off the ground and piled so that air can circulate freely through it. Figure 30 shows how the stack should be made and protected. Good seasoning of lumber is very important.

Poles, piling, posts, and other products that will not be damaged by checking or season cracks should be peeled immediately and seasoned rapidly. After being peeled, poles and piling should be rolled on to skids at least 12 inches off the ground in a place where sun and wind can get at them freely. Put only one layer of poles or piling on each skidway.

Ties are usually best hauled green directly to the railway, where they can be piled according to the buyer's instructions and left to season rapidly. Specialty bolts may be stored in water or given end coatings to prevent stain. Pulpwood may also be stored in water or seasoned rapidly. Some buyers, however, will take only fresh-cut green wood for pulping.

Because it burns better and gives more heat when dry, firewood should always be seasoned before being used. From 25 to 55 percent of the weight of green wood is water; a cord of shagbark hickory loses 800 pounds and gains about one-sixth in heat value while drying.

Three months' seasoning in reasonably dry weather gives green wood 90 percent of the heat value of thoroughly air-dried wood. Complete seasoning takes 6 months to a year. Splitting helps, especially with large hardwoods. Live trees felled in summer dry out faster if the leaves are left on for 2 or 3 weeks. Stacks of cord-

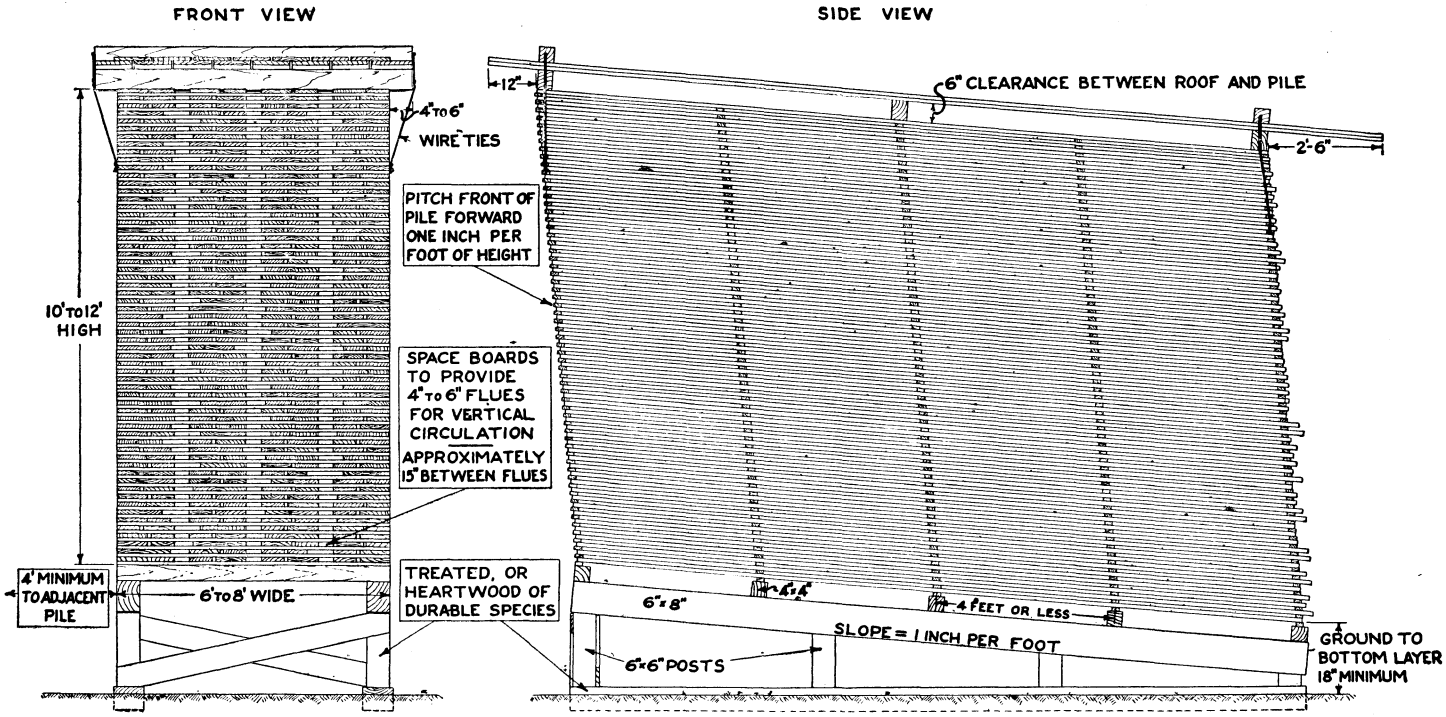

FIGURE 30.—Essential features in piling lumber outdoors for rapid and uniform air seasoning.

wood can be dried outdoors in the sun and wind. For best results the pile should have a cover, or the top layer of sticks may be packed closely and slanted to shed rain. Use bed pieces to keep the bottom layer off the ground. Piling crisscross speeds seasoning.

SELLING FOREST PRODUCTS

A profitable sale is the final step in good forest management. It decides whether the owner's investments in cash and labor have succeeded or failed.

Even under present poor selling practices a huge amount of timber is marketed from small forests, and any improvement in methods of selling would bring just so much more hard cash into the owners' pockets.

Know how much timber you have for sale is a prime rule of good selling. Too many men sell their trees to the first buyer who offers them a lump sum for their stumpage. Such sales are often very profitable—for the buyer.

Reports of work done by farm foresters in 1946 show that it pays to market measured timber.

For example, in Kentucky an owner was offered $7,000 for 310 trees picked by the buyer. After consulting a farm forester, who helped him mark trees for sale, this owner received $12,600 for 199 trees!

In Tennessee a small forest owner delayed accepting $1,800 for the timber on his tract until he talked to a forester. Together, they marked $5,000 worth of timber and left some fine young trees to renew the stand.

An Oregon farmer who had been offered $2,500 for all his timber, harvested piling himself for $2,700 and sold sawlog stumpage for $1,500 more.

In Iowa a lump-sum buyer offered a farmer $75 for all the basswood of over 12-inch diameter on a 20-acre woodland. Marking only mature trees for sale, the farmer and a forester chose trees that brought $250 and opened the stand for faster growth of young trees.

More than anything else, then, the forest owner must know what he has to sell, both in amount and kind. Only when he has measured his timber can he sell it intelligently.

Sell stumpage or converted products.—Selling, like other parts of forest management, requires thought, care, and experience. Unless he has such experience, one of the owner's first steps when considering a sale, should be to ask his local forester about outlets and prices for forest products.

Sometimes the seller will have to decide whether to cut his own timber or to sell it as it stands. A rough calculation may help him decide: add to the stumpage value of the timber the cost of harvesting it (including purchase of tools and supplies, cost of operating equipment, depreciation, and wages for hired help). Subtract the total from the estimated value of the converted product. The difference is profit and wages. Very often, as explained on page 47, the owner will find it well worth while to harvest his timber himself.

Marketing converted products.—One of the problems of the forest owner who wishes to sell converted products will be to select the ones that will bring him the greatest returns. Sawlogs and veneer logs usually bring in the most money, but sometimes part of the crop pays more if sold as a specialty. Tall, straight, well-tapered southern yellow pines, cypress, and sometimes sweetgum (redgum) and other hardwoods may net more as poles or piling than as saw timber. Large, high-grade logs of some hardwoods like sweetgum, yellow-poplar, maple, and magnolia will often bring best prices as veneer. Good white oak sometimes sells at high prices to plants making wine or whiskey barrels.

It may pay to take the long, high-grade logs to a mill cutting large timbers, the shorter ones to a mill cutting lumber. With mixed stands it may be worth while to sell the hardwood and softwood logs separately. Before he "high-grades" or skims off his best stock, though, the forest owner should be sure that he can also sell what is left at a fair price. In the same way, if he plans an integrated cutting of, say, saw timber and ties, he should be sure that the money from the two products will be more than he would get from either product alone.

In selling partly finished wood products, the forest owner must be sure of a market, must know the buyer's specifications, and must have the skill and equipment to turn out the timber at a profit and perhaps to deliver it. He may do all of the work himself or he may hire men to do it for him.

In saw-timber operation, he sometimes cuts the logs and hires the mill to saw his lumber. Then he sells the high-grade lumber and uses the poor stuff himself.

If he hires a contractor to log or deliver his trees, the owner must be able to supervise the work closely. Written contracts are best for any operation. They should include, besides the names of the contracting parties, a description of the work to be done, the rate and time of payment, time limit on the job, and protection of reserve timber from damage by fire or logging damage. Contracts that include felling and bucking should specify which trees are to be felled and what products are to be cut from them.

FINDING A MARKET

Whether the forest owner sells stumpage or converted products, he usually gains by looking over all likely markets before closing a deal. His local forester will know local prices and markets and may also be able to recommend firms farther away. Very often it will pay to advertise in the local paper, or if a good deal of timber is to be sold, in a lumber trade journal.

Of course, the owner will hear about sales his neighbors have made. Also, either in person or by letter, he can ask various wood-using concerns for prices. Railroads and streetcar lines need ties. Along with light, telegraph, telephone, and power companies they also use poles. Railroads and dock, wharf, bridge, and bulkhead contractors in larger towns and cities will quote prices on piling. Brickmakers, bakeries, lime-kilns, packing houses, and fuel dealers buy cordwood. Mining companies will give prices and specifi-

cations on the timber they need, and so will pulp, veneer, and woodworking plants. Sawmills and lumber yards are always interested. If a wood-distillation plant is near, it may buy southern pine, birch, beech, maple, or other woods. A little looking around may show a good many markets.

Getting bids.—Sometimes the local forester will advise the forest owner to write letters to wood-using companies asking them to bid either on his standing timber or on converted products. It is a good idea to ask for bids both by the lump and by measure. When writing letters seeking bids on standing timber, give its location and amount in cords or board feet, the size of the plot in acres, the main kinds of trees in the stand, and the quality of the timber. The buyers will also want to know about logging and ground conditions, whether the trees are second growth or old growth, whether they grew in the forest or came up in an old field, and their range in diameter and height.

Prospective buyers of converted products, should be told the quality, kind, and number of the products; the grade, length, location, kinds of wood they are made from, and anything else that will be helpful.

In all letters the owner should give his name and address, the conditions of sale, final date for placing bids, and when the timber may be examined. To protect himself, he should reserve the right to reject any or all bids. The local forester will have suggestions and advice on these matters.

Some products, like pulpwood, ties, or crude gum for naval stores, usually have standardized prices and are often not sold by bids.

Judging the offers.—In considering bids the owner should keep in mind several things. First, do higher prices at a distant market offset transportation costs? Is the purchaser reliable?

Grading systems are not standardized, and prices for what seems to be the same grade may not be comparable. Neither is scaling uniform; liberal scaling may offset low unit prices or a low-value log rule like the Doyle. Finally, before taking a high price for one forest product, the owner should be sure that he will be able to sell other less valuable ones later.

An owner can sometimes judge the value of his timber by finding out what other tracts have sold for recently. In comparing stands, however, he should remember that the things that bring high prices are desirable kinds of trees or high-grade products, freedom of products from defect, good logging conditions, and nearness to market. Generally, too, a large amount of timber will attract more buyers than a small stand.

SALES CONTRACTS

Most sales of stumpage and some sales of converted products should be covered by a written agreement signed by the buyer, the seller, and at least one witness (see p. 60 for sample timber sale agreement). Even though both parties are perfectly honest, a contract will enable them to avoid many misunderstandings that might arise.

Stumpage contracts.—There are several usual ways of making stumpage sales. Sometimes the purchaser agrees to cut the timber and pay for it by scaling it, after felling, by an agreed-upon log rule. However, the buyer is then apt to take only the high-grade logs and leave the low-grade logs unless he is bound by contract to take all marked trees. Before closing a deal, buyer and seller should agree on what a merchantable log is. Moreover, the seller should be sure that the purchaser scales the logs fairly. When other products like poles or cordwood are sold by this method the possibility of high grading is less likely.

Again, payment may be based on the actual measured amount of lumber sawed out of the timber by the purchaser. Here too there is danger of high grading and the chance that lumber will be wasted through careless sawing. The seller should have some way of checking the lumber tally. In value-sharing sales the owner receives the share of the sale value of the lumber sawed.

Another method is the minimum-guarantee stumpage sale. Here, for a tract expected to contain 100,000 board feet, the buyer might agree to pay $600 plus $6 per M for all timber cut in excess of 100 M feet. If the minimum guarantee is high enough this is a good way to sell stumpage.

Even if the agreement is by word of mouth, the following points should be taken up before a stumpage sale is closed: Description of the sale area, kind and amount of timber to be cut, owner's guarantee of title to the timber, sale price, provision for payment before cutting, definition of trees to be cut (marked trees, stump-diameter limit, species, etc.), definition of merchantable trees and products, time limits for cutting and removing timber, time, place and method of measurement and grading (not needed for lump sales), protection of reserved trees from fire and logging damage, buyer's rights of entrance and exit to the forest, payment of taxes, and manner of settling disagreements. Especially in large sales, a performance bond may be desirable.

Sales of converted products.—When selling converted products on a reliable market, when demand is good, or when products are delivered shortly after cutting, a written contract is often omitted. But all agreements, written or verbal, should specify at least the method of measurement and grading, limits of merchantability, quantity, rate and point of delivery, time limit, and method and time of payment.

COOPERATIVES FOR SELLING TIMBER

Because forest marketing cooperatives can handle large amounts of timber, they often secure much better prices for it than individual owners could. Sometimes owners of small amounts of timber merely join informally to pool one or two shipments or to share sawing and handling expenses.

Timber owners who wish to form a marketing cooperative or sell their timber in a pool can get help from their local forester. Sometimes, however, owners plan a marketing cooperative when their real need is to grow timber. Timber management is almost as important to a co-op as marketing is. Unless members care for their woodlands, the co-op soon will have nothing to sell.

SAMPLE TIMBER SALE AGREEMENT

_____ _____, of _____, _____,
(I or we) (Name of Purchaser) (Post Office) (State)
hereinafter called the purchaser, agree to purchase from _____
(Seller's name)
_____ of _____, _____, hereinafter called
(Post Office) (State)
the seller, the designated trees from the area described below.

I. Description of Sale Area:
(Describe by legal subdivisions, if surveyed, and approximate, if not)

_____

_____

II. Trees designated for cutting: (Cross out A or B — use only *one* clause)

A. All _____ trees marked by the seller, or his agent,
(Species)
with paint spots below stump height; also dead trees of the same species which are merchantable for _____.
(Kind of forest products)

B. All _____ trees merchantable for _____
(Species) (Kind of forest products)
_____ which measure _____ inches or more outside the bark at a point not less than 6 inches above the ground; also other _____ trees marked with paint spots below stump
(Species)
height by the seller or his agent.

III. Conditions of Sale:

A. The purchaser agrees to the following:

1. To pay the seller the sum of $_____ for the above-described trees and to make payments in advance of cutting in amounts of at least $_____ each.

2. To waive all claim to the above-described trees unless they are cut and removed on or before _____.
(date)

3. To do all in his power to prevent and suppress forest fires on or threatening the Sale Area.

4. To protect from unnecessary injury young growth and other trees not designated for cutting.

5. To pay the seller for undesignated trees cut or injured through carelessness at the rate of $_____ each for trees measuring 10 to _____ inches in diameter at stump height and $_____ each for trees _____ inches or over in diameter.

6. To repair damage caused by logging to ditches, fences, bridges, roads, trails or other improvements damaged beyond ordinary wear and tear.

7. Not to assign this agreement in whole or in part without the written consent of the seller.

B. The seller agrees to the following:

1. To guarantee title to the forest products covered by this agreement and to defend it against all claims at his expense.

2. To allow the purchaser to use unmerchantable material from tops of trees cut or from trees of _____ species for necessary

logging improvement free of charge, provided such improvements are left in place by the purchaser.

3. To grant the freedom of entry and right-of-way to the purchaser and his employees on and across the area covered by this agreement and also other privileges usually extended to purchasers of stumpage which are not specifically covered, provided they do not conflict with specific provisions of this agreement.

C. In case of dispute over the terms of this agreement we agree to accept the decision of an arbitration board of three selected persons as final. Each of the contracting parties will select one person and the two selected will select a third to form this board.
Signed in duplicate this _____ day of _____ 194__.

_____
(Purchaser)

_____
(Witness)

_____
(Witness)

_____
(Seller)

_____
(Witness)

_____
(Witness)

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